



Trawl Selectivity Estimates of *Thryssa dussumieri* (Valenciennes, 1848) in Square and Diamond Mesh Codends

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Abstract

Codend selectivity of *Thryssa dussumieri*, an important trawl resource along Gujarat coast was studied using covered codend method. The selectivity estimates were worked out for 40 mm diamond and square mesh codends by staked haul method to account variation associated with multiple hauls considered for deriving the selectivity. The length at 50% retention of the species for the 40 mm diamond and square mesh codends were worked out as 8.84 ± 0.16 and 10.20 ± 0.12 cm respectively. The selection range, selection factor and selection ratio for the diamond mesh codend was 7.96 ± 0.42 cm, 2.21 and 0.9 respectively and for the 40 mm square mesh codend these values were 3.76 ± 0.19 cm, 2.55 and 0.37 respectively. Considering the length at first maturity of the species as 125 mm, the optimum mesh size for 40 mm diamond mesh and square mesh codend were worked out as 56.6 and 49 mm respectively for conservation of the species.

Keywords: Selectivity, *Thryssa dussumieri*, codend, square mesh

Introduction

Northwest coast of India is an important trawling ground along the Indian coast. Gear wise landings show that 55% of the total vessels are trawlers, contributing about 60% of the total catches. During the last decade there was a substantial increase in the number of fishing vessels and improvements in terms of fishing capacities and subsequent decrease

in the catch per unit effort from the fishing vessel along the Gujarat coast (Mathai et al., 2003).

Large quantities of bycatch is generated along the Gujarat coast, mostly by trawlers due to the use of illegal mesh sizes in the codends, which often ranges from 15-20 mm. The bycatch often comprised of juveniles of commercially important species along with non-commercial species (Madhu, et al., 2015).

The total clupeid landings along Gujarat coast during 2014-15, was 28 231 tonnes out of which, landings of *Thryssa* sp. was 715 tonnes (CMFRI, 2015). Landings of *Thryssa* sp. formed 18.7% of the total pelagic and 5.4% of the total marine fish landings in Gujarat. The length of the fish in the fishery ranged from 100 to 150 mm and the length at first sexual maturity is reported as 125 mm (Hoda, 1976).

Knowledge on selectivity of commercially important gears is vital for effective management, monitoring and sustainable harvest of resources. Use of selective fishing gears, can regulate the length of capture and hence increase the yield per recruit of the target species and also help in reducing discards (MacLennan, 1992; Boopendranath, 2008). Among different technical measures intended to improve the selectivity of trawl gears, modifications made to the shape and size of the codends was found to be the most adopted due to the conceptual simplicity and ease of installation (Rangonese & Bianchini, 2006). Trawl codend selectivity of a species is often derived from multiple tows by methods like covered codend and trouser trawl (Wileman, 1992). But the selection parameters have a variance associated due to retention data considered from multiple hauls (Fryer, 1991) and this needs to be accounted for making the selectivity estimates more reliable (Macbeth, et al., 2005). Replication estimation of

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dispersion is one method by which the variability in the selection parameters can be accounted (Miller et al., 2004).

Reports on the codend selectivity estimates for commercially important species along the Gujarat coast are relatively few (Mathai et al., 2003; Boopendranath & Pravin, 2005). The Gujarat Government has enacted 40 mm square mesh codend mandatory for the trawlers operating along the coast (Anonymous, 2003). Although the Government has made 40 mm square mesh codends mandatory in the trawls, the data on selectivity estimates for this codend along the Gujarat coast is very limited (Boopendranath & Pravin, 2005).

The trawl codend selectivity estimates of different commercially important species along the Indian coast were worked out by Kunjipalu et al., 1994; Kunjipalu et al., 1996; Kunjipalu et al., 2001; Prakash et al., 2008; Madhu et al., 2011; Boopendranath et al., 2012; Madhu et al., 2013; Prakash et al., 2013) and others. The selectivity estimates of *Thyssa purava* estimated by Varghese et al., (1996) for 20 mm square and diamond mesh codends were, 67 and 68 mm total length (TL) respectively.

This article reports the results of the selectivity experiments with respect to *Thyssa dussumieri* carried out using 40 mm square and diamond mesh codends off Veraval coast, Gujarat.

Material and Methods

Selectivity experiments were carried out onboard the ICAR-Central Institute of Fisheries Technology Research Vessel MFV Sagarkripa (15.5 m L_{OA} , 124 hp stern trawler) in the commercial fishing grounds off Veraval, Gujarat, at depth zone of 20-45 m. A 34 m high opening bottom trawl (HOBOT) was used for the 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 and the 40 mm and square and diamond mesh codends were used alternatively during the selectivity experiments. V-form otterboards with dimensions of 790 x 1360 mm weighing 85 kg each were used throughout the study. Codends were 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 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 whenever a sub-sampling was carried out and a 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 the species was calculated as $L_{50} = -a / b$, selection range (SR) = $L_{75} - L_{25}$, selection factor (SF) = $L_{50} / \text{mesh size}$, 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

Data from 19 hauls were used for the analysis. Escapement data of *T. dussumieri* from 10 hauls using the 40 mm diamond mesh codend was available and a total of 1239 individuals were retained in the codend and 1802 escaped to the cover. The details of the estimated parameters, the covariance matrices and the size selection curve for the 40 mm diamond-mesh codend is shown in Table 1 and Figure 1 respectively. The population retained by the codend and cover is also shown in the same figure. The length at 50% retention ($L_{50} \pm s.e$) of the species was estimated as 8.84 (0.16) cm. The selection range was worked out as 7.96

(0.42) cm. The selection factor and the selection ratio for this codend were worked out as 2.21 and 0.9 respectively.

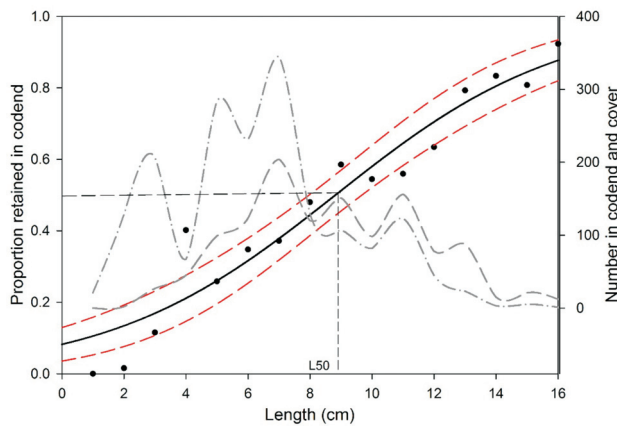


Fig. 1. Selection curve of *T. dussumieri* in 40 mm diamond mesh codend. Thick continuous line is selection curve. Thick dashed line indicates L_{50} . Dash-dot-dash curve indicates the population escaped to cover. Dashed thin line shows population retained in the codend. Medium dashed lines are 95% confidence bands of the selection curve.

Escapement data of *T. dussumieri* from 9 hauls using the 40 mm square mesh codend revealed that out of a total of 1 819 individuals that entered the codend, 1 301 individuals escaped to the cover and 518 were retained by the codend. The details of the estimated parameters, the covariance matrices and the size selection curve for the 40 mm diamond-mesh codend is shown in Table 1 and Figure 2 respectively. The length at 50% retention ($L_{50} \pm s.e.$) of the species was estimated at 10.20 (0.12) cm. The selection range was 3.76 (0.19) cm. The selection factor and the selection ratio for this codend were estimated as 2.55 and 0.37 respectively.

The codend selectivity estimates for this species are not reported along the Gujarat coast. Varghese et al., (1996) reported selectivity estimates for a closely related species *Thryssa purava* for 20 mm diamond and square mesh codends along Cochin coast as 3.37 and 3.39 respectively. The calculated (re-estimated using the data from graphs) L_{50} values for 40 mm mesh size from the selection factor, works out to be around 13 cm, which is much higher than the values reported in this study, though the values cannot be directly compared due to gear and vessel differences and method of data collection.

The selectivity estimates for *Thryssa* sp. for 30 mm square-mesh codend was reported by Kunjipalu et al. (2001), the L_{50} for the species was reported as 11.1 cm and the selection factor as 3.70, which is higher than the estimates from this study. The results could not be compared since the selectivity for all *Thryssa* sp. were collectively estimated. Pinto (1999) had reported the selectivity estimates for *Thryssa vitirostris*, a species closely related to *T. dussumieri* along the Sofala coast of Mosambique and the L_{50} for this species were recorded as 8.7 in 55 mm and 13.3 mm in 60 mm diamond mesh codend, which are close to the results obtained in this study. This species has a narrow body and the selection properties for this shape are reported to be comparatively higher (Matsushita & Ali, 1997).

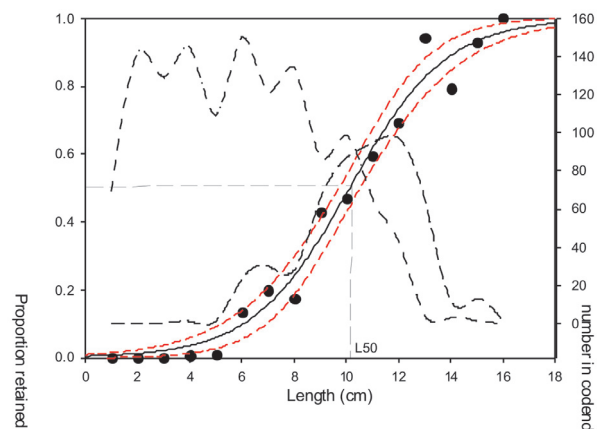


Fig. 2. Selection curve of *Thryssa dussumieri* in 40 mm square mesh codend. Thick continuous line is selection curve. Thick dashed line indicates L_{50} . Dash-dot-dash curve indicates the population escaped. Dashed line shows population that was retained in the codend. Thin dashed lines are 95% confidence bands of the selection curve.

Based on this study, it can be assumed that the presently used codends in the fishery are grossly insufficient for the conservation of *T. dussumieri*. The L_{50} values of 8.84 ± 0.16 cm and 102.0 ± 0.12 cm for the diamond and square mesh codends are less compared to the LFM_{50} of 125 cm for this species and hence this study suggests mesh sizes of 56.6 mm and 49.0 mm for the diamond and square mesh codends respectively for conservation of the species.

Further studies need to be taken up, using different mesh sizes and shapes for other species co-occurring with *T. dussumieri* in the fishery to draw a suitable strategy for implementation of mesh size regulations for trawl gears operated along Gujarat coast.

Table 1. Selectivity estimates of *T. dussumieri* in diamond and square mesh codends

Codend type	Diamond 40 mm	Square 40 mm
Total individuals in the codend	1239	518
Total individuals escaped to cover	1802	1301
L_{50} (cm)	8.84 (0.16)*	10.20 (0.12)
Selection Range(cm)	7.96 (0.42)	3.76 (0.19)
Selection Factor	2.21	2.55
Selection Ratio	0.9	0.37
Parameter estimates		
a	-2.44 (0.19)	-5.91 (0.42)
b	0.28 (0.27)	0.58 (0.07)
R11	0.013	0.080
R21	-0.0016	-0.008
R22	0.00021	0.001
Length at first sexual maturity (LFM_{50})(mm)		125#
Optimum mesh size based on LFM_{50} (mm)	56.6	49.0

* Standard errors are given in parenthesis and are corrected for the between-haul variation using the replication estimate of dispersion. # Hoda, 1976

Experimental designs to assess different parameters, affecting the selection properties of the codend like thickness of twine, vessel speed, circumference of the codend, seasonal affects etc. need to be further investigated.

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