Indian J. Fish., ***53****(4) : 425-430, Oct.-Dec., 2006*

Cephalopod fishery and population dynamics of *Loligo duvauceli* (Orbigny) off Saurashtra region, Gujarat

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ABSTRACT

The fishery of cephalopods and some aspects of population dynamics of the Indian squid *Loligo duvauceli* from Veraval and Mangrol in Saurashtra region was studied for the period 1996-99. The average annual landing of cephalopods by trawl in Veraval and Mangrol were estimated at 3911t and 1030t respectively, which contributed 4.8 and 5.7% of the total fish landings in Veraval and Mangrol. *Loligo duvauceli* dominated the catch (58%) , followed by *Sepia aculeata* (19%), *S. elliptica* (19%), *S.pharaonis* (3%) and *Sepiella inermis* (1%). The length weight relationship was estimated for males and females of *Loligo duvauceli* as $W= 0.109011 L^{2.634609}$ and $W = 0.314656 L^{2.185796}$ respectively. The estimates of VBGF parameters were L_{∞} = 303mm and K= 0.98 year $^{-1}$. The mortality rates values Z, M, F were 3.94, 1.94 and 2.20 respectively. The exploitation rate was 0.56. The present study shows that the resource is exploited above the optimum level and the effort has to be reduced for sustaining the resource for long term exploitation.

Introduction

Cephalopods form 4-5% of the total marine fish production in India, and are under heavy fishing pressure because of their high value as an exportable commodity (Meiyappan *et al.*, 2000). Stock assessment and biology of important cephalopod resources along the Indian coast have been studied by several researchers (Rao 1988; Meiyappan *et al*., 1993; Mohamed, 1996; Mohamed and Rao, 1997). Studies on the cephalopod fishery and population dynamics of *Loligo duvauceli* from Saurashtra waters are limited (Kasim, 1985). As the fishing pressure on cephalopods is increasing in recent years, an attempt was made to study the fishery of cephalopods and some aspects of population dynamics of the Indian squid *Loligo duvauceli*, which contributes more than 50% of the cephalopod landings in this region.

Coastal Gujarat comprises three distinct regions viz., Saurashtra, Kutch and south Gujarat. The major concentration and activities of trawlers are centered around Saurashtra region which harbours nearly 75% of the total trawl units available in Gujarat and contribute more than half of the total fish production of the state (Sehara, 1998).

Two major fish landing centers of Saurashtra region are Veraval and Mangrol and the present study was based on the cephalopod landings in these two fish landing centres.

Materials and methods

The study was conducted from 1996-1999 from Veraval and Mangrol. Field observations were made fortnightly to collect data on catch, effort, length, weight and species composition of cephalopods caught by trawlers operating from Veraval and Mangrol. The monthly and annual estimates were made following the procedures outlined by Srinath *et al*. (2005)

L .duvauceli, which is the dominant species landed was sampled biweekly (n = 4045) for further studies. Length weight relationship of *L .duvauceli* was calculated following the formula $W = a L^b$ (Le Cren, 1951). The difference between the slopes of the regression lines of males and females were tested by ANCOVA (Snedecor and Cochran, 1967). Student's t-test was used to determine if regression coefficients differed from the isometric value 3. Data on maturity and spawning during monsoon (June – August) were not available due to suspension of trawl fishery. Sex ratio and maturity stages were based on the examination of about 950 specimens.

The growth parameters were estimated with the size range of 25 – 295 mm dorsal mantle length (DML). The monthly length frequency data arranged in 10 mm class interval for the period 1996-99, was pooled and analysed using ELEFAN module of FiSAT for estimation of von Bertalanffy's Growth parameters, L_∞ and K (Gayanilo *et al*., 1995) while t_0 was considered as '0' (Sparre *et al*.,1989). The total instantaneous mortality rate (Z) was estimated from the length converted catch curve method (Pauly, 1983a) and natural mortality rate (M) was estimated from Pauly's empirical formula (Pauly, 1983 b).

$$\text{Log}_{10} M = -0.0066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T$$

Where L_∞ and K are von Bertalanffy's growth parameters and

T = Surface seawater temperature (taken here as 27^0 C).

The fishing mortality rate F was arrived by Z-M. The exploitation rate was estimated by the ratio of fishing mortality/ total mortality.

$$E = F/ F+M$$

The yield /recruit was estimated using the relative yield/recruit model of Beverton and Holt (1957).

Results

Fishery at Veraval

The fishery is open from September to May and remained closed during the monsoon season from June to August. The average annual catch of cephalopods for the period 1996-99 was estimated as 3911 t. Maximum catch during the period was recorded in April (600 t) and minimum in May (173 t). During the 1996-99 period, there was a progressive decline in the catch from 4379 t estimated in 1996-97 to 3928 t in 1997-98, which further decreased by 28% (1392 t) in 1998-99.The estimated effort increased from 90370 units in 1996-97 to 90943 in 1997-98 and further decreased to 58059 units in the subsequent year. Average catch per hour during the period ranged from 2.9kg to 5 kg with annual average of 4.1 kg (Fig 1). The contributions of cephalopods to the total trawl landings in Veraval fluctuated from year to year and the average contribution was 4.8%.

Fishery at Mangrol

The estimated average annual catch of cephalopods from Mangrol during the period was 1030 t. Maximum catch during the period was in October (229 t) and minimum in March (62 t). The catch decreased from 1211 t in 1996-97 to 1037 t in 1997-98 and further decreased to 797 t in 1998-99. The average catch per hour of cephalopods ranged between 2.3 kg to 8.2 kg, with an average of 4.2 kg (Fig 1). The contribution of cephalopods to the total trawl landings fluctuated from year to year with an average percentage of 5.7.

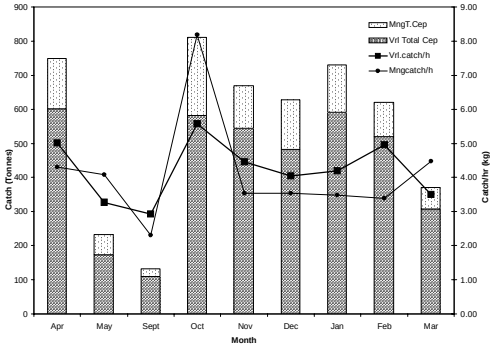

Fig 1. Estimated average annual cephalopod landings in Veraval and Mangrol (1996-1999)

Species composition

Of the five species of cephalopod landed during the period 1996-99, the squid *Loligo duvauceli* dominated (58%) the fishery. The other species landed were cuttlefishes like *Sepia aculeata* (19%), *S. elliptica* (19%), *S. pharaonis* (3%) and *Sepiella inermis* (1%). Maximum landings of squid was recorded in April (460 t) in Veraval and in October (153 t) in Mangrol. Cephalopods were abundant during January to April and October to December (Fig 2).

Biology of Loligo duvauceli

Maturity and spawning: Mature and maturing males and females were

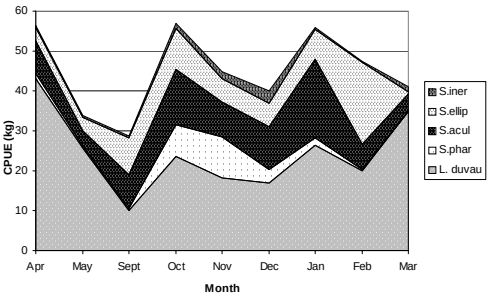

Fig 2. Seasonal abundance of cephalopods in Veraval

observed through out the year. Mature specimens were found through out the year indicating breeding activity almost through out the year with peak during post - monsoon in December.

Sex ratio : Females were dominant during January, March, May and December, whereas males were dominant in other months. The overall male to female ratio was 1: 1.3. The Chi square values were significant at 5% level in February, September, October and November. The largest male and female specimens recorded measured 285mm and 275mm DML respectively.

Length weight relationship: Length – weight relationship for *Loligo duvauceli* was calculated separately for males and females. The following equations describe the length –weight relationship

Male : $\log W = -2.21631+2.634609 \log L$ ($r = 0.95$)

Female: $\log W = -1.15628 + 2.185796 \log L$ ($r = 0.96$)

Analysis of covariance indicated that the slope of the curve of males and females are significantly different at the 5% level. Both b values were also significantly ($P<0.01$) different from the isometric value 3 indicating allometric growth.

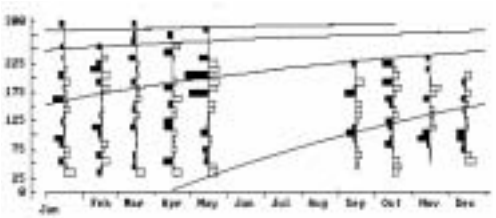

Fig 3. Growth curve fitted using ELEFAN for *Loligo duvauceli* for the year 1996-98 (Rn=0.142)

Growth, mortality, exploitation and yield/recruit : Based on the analysis of length frequency data, the estimates of VBGF parameters were: L_{∞} = 303 mm and K = 0.98 year^{-1}. The growth curve computed with these parameters is given in Fig. 3. Thus the VBGF for *L. duvauceli* can be written as

$$L_t = 303\ (1- e^{-0.98\ (t)})$$

The squid attains a size of 189, 260 and 287 mm at the end of the 1st, 2nd and 3rd year respectively. The t_{max} was calculated as 3.06 years. The recruitment of *L. duvauceli* to the fishery was almost continuous during the year with single peak recruitment. The major recruitment period for the species is from March to September.

Mortality rates were estimated from the length converted catch curve. The values of Z, M and F were 3.94, 1.74 and 2.20 respectively (Fig. 4). The exploitation rate of *L. duvauceli* was 0.56, more

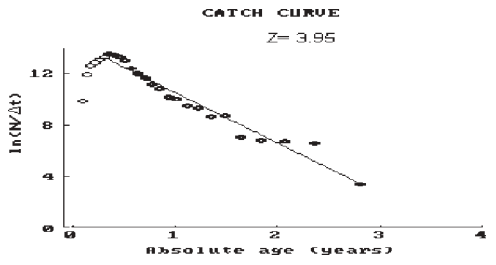

Fig 4. Estimation of total mortality rate by catch curve method for *L. duvauceli* exploited by trawls

than E_{max} 0.44. The present exploitation rate of 0.56 is above the optimum level of 0.5. The MSY is estimated as 3480 t, which is lower than the present yield of 3912 t.

Discussion

During the period of study a declining trend in catch was observed over the years. The CPUE and catch per hour also showed a declining trend in first two years. However, the CPUE increased in 1998-99 with a decrease in effort. Silas *et al*. (1985) also noticed an increase in production with decrease in effort in cephalopod landings along the coast of Gujarat.

With regards to species composition, Meiyappan *et al*., (2000) observed that the squid *L. duvauceli* contributed more than a third of the Indian cephalopod production during 1990-94. Seasonal abundance of cephalopods recorded during January–April and October-December did not vary much from the earlier reports (Meiyappan *et al*., 2000). Dominance of *L. duvauceli* in Saurashtra waters was also reported by Kasim (1985). During 1996-99 also *L. duvauceli* contributed more than 50% of the total cephalopod landings.

Length-weight relationships derived showed that both male and female *L. duvauceli* conform to allometric pattern of growth. Similar observations have been made by Rao (1988), Meiyappan and Srinath (1989) and Mohammed (1996) in this species.

Studies on spawning by earlier workers (Silas *et al*., 1985; Rao, 1988; Mohamed, 1996) shows that *L. duvauceli* spawns through out the year with peak spawning during post- monsoon along the west coast. In the present study also the spawning was found to occur through out the year with peak during post - monsoon

and the maximum recruitment of young ones to the fishery was observed in April. Rao (1988) suggests the possibility of post-spawning mortality in female *L. duvauceli*. In the present study it has been observed that peak spawning in the post-monsoon period coincides with the high dominance of males in the catches, suggesting the possibility of post-spawning mortality in females. Fields (1965) opined that female *L. opalescens* spawn only once and die. Rao, 1988 also found evidence of single spawning from the analysis of intra-ovarian eggs in *L. duvauceli*.

L_∞ and K reported by the early workers (Silas *et al*., 1985; Kasim 1985; Rao, 1988; Meiyappan and Srinath, 1989; Meiyappan *et al*., 1993; Chakraborthy *et al*.,1997; Mohamed and Rao 1997; Karnik *et al.,* 2003) ranged between 200 mm to 385 mm and 0.49 to 1.4. In the present study the L_∞ value is lower than that reported by Kasim (1985) from Saurashtra waters in 1980's. The probable reason for this must be higher level of fishing intensities to which these resources are subjected to at the present. The values are almost equal to that obtained for squids from Mumbai waters (Karnik *et al*., 2003).

The natural mortality (M) of 1.74 is well within the range obtained for this species from India (Meiyappan *et al*., 2000). The exploitation rate (E) of 0.56 is higher than E reported by Kasim (1985) when the resource was under exploited. The exploitation rate shows that the resource is exploited above the optimum level and the effort has to be reduced for sustaining the resource for long term exploitation.

Acknowledgments

The authors express their gratitude to Dr. K. SunilKumar Mohamed, Dr. C. Muthiah and Dr. Rani Mary George.

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Date of Receipt : 21-1-06
Date of Acceptance : 24-7-06