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Sciaenid fishery off Visakhapatnam with some aspects of population dynamics of *Johnius carutta* (Bloch)

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ABSTRACT

The average annual catch of sciaenids by small-mechanized units operated off Visakhapatnam was 465 t, which formed 5.76% of the total landings. Of the thirteen species of sciaenids landed, *Johnius carutta* and *Nibea maculata* dominated the fishery. The estimated asymptotic length (L_∞) and growth constant (K-year) of *J. carutta* were 295 mm and 0.40, respectively. The size at first maturity was 154 mm and the spawning season was during March - May. The mortality rates Z, F and M were 3.02, 2.05 and 0.97 respectively. The exploitation rate of 0.68 indicated heavy exploitation of the species. The yield/recruit curves showed that the exploitation rate could be brought down to E_{max} (0.57) without affecting the catch.

Introduction

Sciaenids constitute one of the commercially important demersal finfish resources landed by small-mechanized units (small trawlers and sona boats) off Visakhapatnam. Detailed information is available on various aspects of fishery and biology of sciaenids from Andhra Pradesh (Murty, 1980, 1984; Rao, 1967, 1978, 1981, 1983). Studies on the population dynamics of *J. carutta* of Andhra waters are limited (Murty, 1986; Rao *et al.*, 1992 in Chakraborty *et al.*, 2000). As this species is subjected to increased fishing pressure during the recent years due to increase in fleet size, an attempt was made to study the changes in the fishery and some aspects of the population dynamics of *J. carutta*.

Materials and methods

Field observations were made weekly twice to collect the data on catch, effort, length, weight and species composition from the commercial small-mechanized units (small trawlers and sona boats) operated off Visakhapatnam during 1990-99. These are wooden boats (small trawlers: 9.2-11.3 m OAL, 63-93 Hp engine and 3-5 days voyage; sona boats: 13.1m OAL, 102 Hp engine and 8-15 days voyage), which operate four-seam shrimp trawl with 15-25 mm cod end mesh size. The monthly and annual estimates of catches were made following the procedure adopted by Fishery Resource Assessment Division of Central Marine Fisheries Research Institute.

J. carutta (Bloch), one of the dominant species landed was considered for further studies. Length weight relationship of *J. carutta* was calculated following the formula $W = a L^b$ (Le Cren, 1951). The difference between the slopes of the reggression lines of males and females were tested by ANACOVA (Snedecor and Cochran, 1967). Size at first maturity was determined by plotting the percentage of mature fish (stage IV and above) against the total length (Thomas, 1969). Percentage distribution of gravid and oozing females (V&VI) over time was considered for determining the spawning season.

The length frequency data for the period 1994-99 was pooled and subjected to ELEFAN module of FiSAT for estimation of von Bertalanffy's Growth Parameters, L_∞ and K (Gayanilo *et al.*, 1995). t_0 was considered as '0' (Sparre *et al.*, 1989). The total mortality rate (Z) was estimated from the length converted catch curve method (Pauly, 1983 a) and natural mortality rate (M) was estimated from Pauly's empirical formula (Pauly, 1983b).

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

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

T= Surface sea water temperature ($27\ ^0C$)

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

$$E = F / F + M$$

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

Results

Fishery

The average annual catch of sciaenids for the period 1990-99 was 465 t, which contributed to 5.76 % of the total small-mechanized unit's catches (Table 1). An annual catch of 308 t recorded in 1990, sharply increased to 570 t in 1991 and to 629 t in 1996, followed by a steep decline to 223 t (1999), which was the lowest catch during the period. The catch

TABLE 1: *Catch and effort data of sciaenids in small mechanised units off Visakhapatnam*

Year	Units	Hours	Catch (t)	CPUE (kg/unit)	Cph (kg/hr)	Percentage in total catch
1990	22802	704962	308	13.50	0.44	4.19
1991	25633	866119	570	22.22	0.66	6.47
1992	18830	867758	500	26.55	0.58	6.80
1993	20340	921633	567	27.87	0.62	6.33
1994	18669	733397	505	27.05	0.69	5.60
1995	14895	759413	510	34.24	0.67	6.33
1996	16438	879614	629	38.26	0.72	6.11
1997	14937	430671	343	22.96	0.80	4.40
1998	14759	530064	491	33.28	0.93	5.73
1999*	10934	503455	223	20.38	0.44	5.02
Total	178237	7197086	4645	26.06	0.65	5.76

* The data for the year is for 11 months since May is declared as closed season

rate (Cph) gradually increased from 0.44 kg (1990) to 0.93 kg (1998) and thereafter declined to 0.44 kg (1999).

The analysis of a ten yearly data on five yearly basis showed that the fishery decreased by only 10% in spite of 24% decrease in effort (hours) during the second half. The number of units operated also decreased by 32% during later half. The Cph and contribution of sciaenids to total trawl landings was also better during the later period

The Cph of sciaenids ranged between 0.8 kg in March and 1.3 kg in July with comparatively high catch rate being observed from June to December.

Species composition

Of the thirteen species of sciaenids landed during the period 1990-99, *N. maculata* (18.4%) and *J. carutta* (18.2%) dominated the fishery. The other major species landed were *Pennahia macrophthalmus* (12.5%), *Otolithes ruber* (10.4%), *J. amblycephalus* (9.8%), *J. dussumieri* (9.4%), *Johnieops vogleri* (7.7%), *Kathala axillaris* (7.1%), *Protonibea diacanthus* (3.2%) and *Atrobucca nibe* (2.9%). In addition, little quantities of *J. macrorhynus*, *Panna microdon* and *Chrysochir aureus* also landed at Visakhapatnam. *Johnius carutta*, *K. axillaris* and *N. maculata* were the dominant species during the first part of the decade whereas *Pennahia macrophthalmus*, *Johnius amblycephalus* and *O. ruber* were dominant during the later part.

Biology of Johnius carutta (Bloch)

Length – weight relationship

A total of 614 (307 male and 307 female) fish in the length range of 90 – 220 mm were considered for determining the length-weight relationship. The relationship was established separately for male and female.

Male : $\log W = \log -4.97749 + 3.04798 \log L$ ($r = 0.94$)

Female : $\log W = \log -4.85011 + 2.912804 \log L$ ($r = 0.96$)

Since there was no significant difference between the slopes, a combined relationship was considered for both the sexes.

$\log W = \log -4.9304 + 3.027867 \log L$ ($r = 0.95$)

Size at first maturity

A total of 782 female fish collected during the period were examined for determining the size at first maturity. *J. carutta* attained maturity at the age of one year eight months at the size of 154 mm total length (Fig. 1).

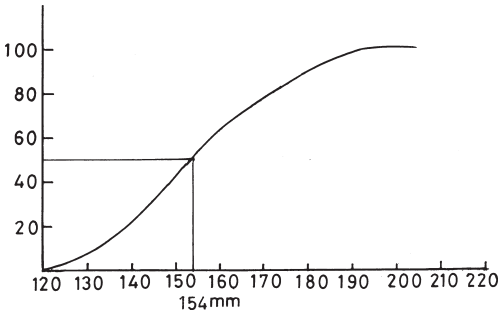

Fig. 1. Size at first maturity of *J.carutta.*

Spawning

The spawning season of *J. carutta* lasted for a short period during March – May when the spawners were abundant.

Growth, mortality, exploitation and yield / recruit

The growth parameters were estimated with the size range of 90-210 mm in total length based on the analysis of length frequency data of the fish, the estimates of VBGF parameters were: L_{∞} =295 mm and K = 0.40 year $^{-1}$. Thus the VBGF for *J. carutta* can be written as:

$L_t = 295 (1\text{-}e^{-0.40(t)})$

The fish attained a size of 97.5, 162.5 and 206.2 mm at the end of 1st, 2nd and 3rd year respectively (Fig. 2). The recruitment of *J. carutta* to the fishery is almost continuous during the year with peak recruitment recorded during August (Fig. 3). The major recruitment period for the species is June-October.

The mortality rates estimated separately for each year (Fig. 4) from the length converted catch curve are presented below:

Year	Z	M	F
1994	2.94	0.97	1.97
1995	3.64	0.97	2.67
1996	2.93	0.97	1.96
1997	3.05	0.97	2.08
1998	2.65	0.97	1.68
1999	2.89	0.97	1.92
Avg.	3.02	0.97	2.05

The average values of Z, M and F were 3.02, 0.97 and 2.05 respectively. These values were used for further analysis.

The exploitation rate of *J. carutta* was 0.68, more than the E_{max} 0.57 indicating over exploitation of the species. The present exploitation rate of 0.68 for the species is above the optimum level of 0.5. The yield/recruit curve showed that the maximum sustainable yield could be obtained at 0.57 exploitation rate (Fig. 5). The maximum yield that can be obtained at E_{max} is 195 gm (1.95) per recruit. At present exploitation rate, it is 190 gm (1.90). The optimum biomass can be obtained at exploitation rate of 0.31, but with present rate, the biomass/ recruit is very low. Though the present exploitation rate is more, the yield/recruit is not affected but the relative biomass is affected. So to get optimum yield and biomass / recruit the exploitation rate should be stabilized between 0.32 – 0.57.

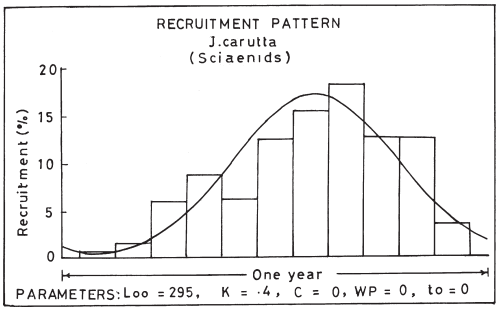

Fig. 3. Recruitment pattern of *J.carutta* from Visakhapatnam waters exploited by trawlers during 1994-99.

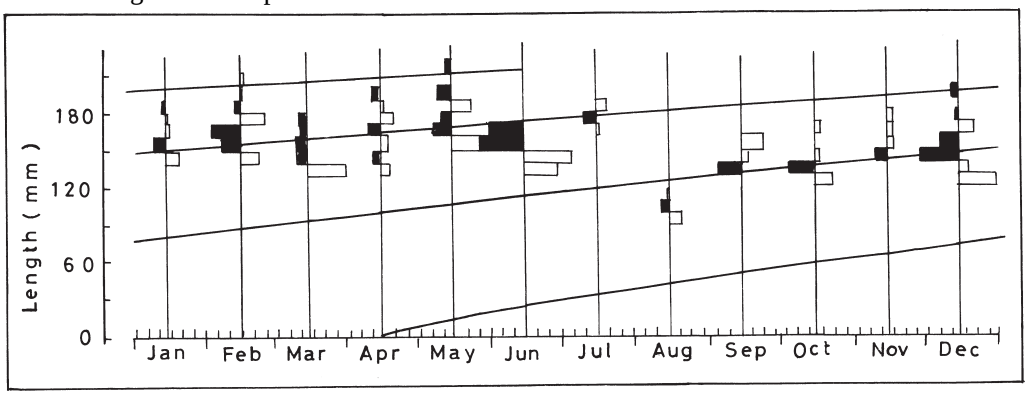

Fig. 2. ELEFAN growth curve for *J.carutta* obtained for the year 1994-99 through FiSAT programme.

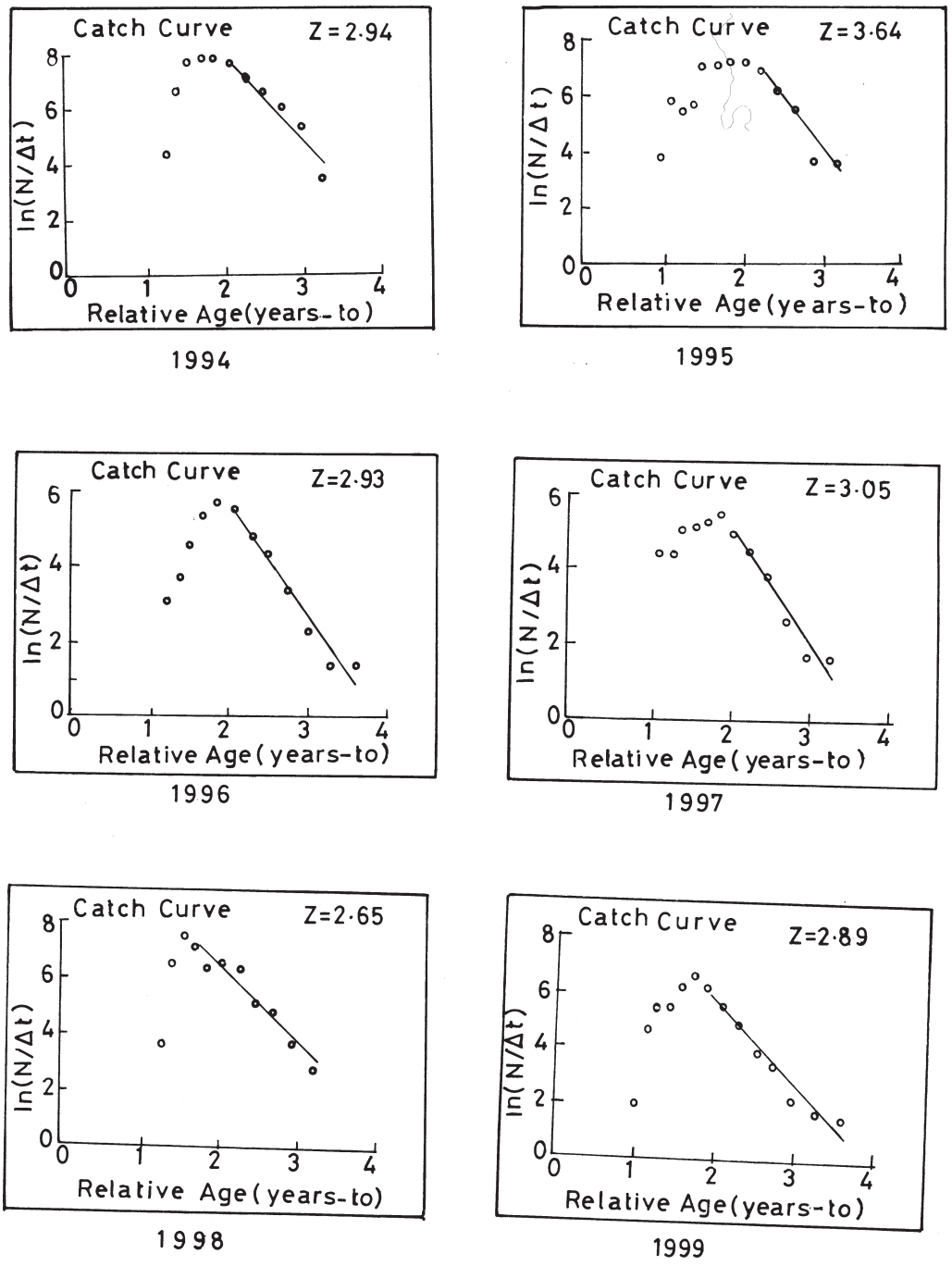

Fig. 4. Estimation of total mortality rate by catch curve method for *J.carutta* exploited by trawls along Visakhapatnam during 1994-99

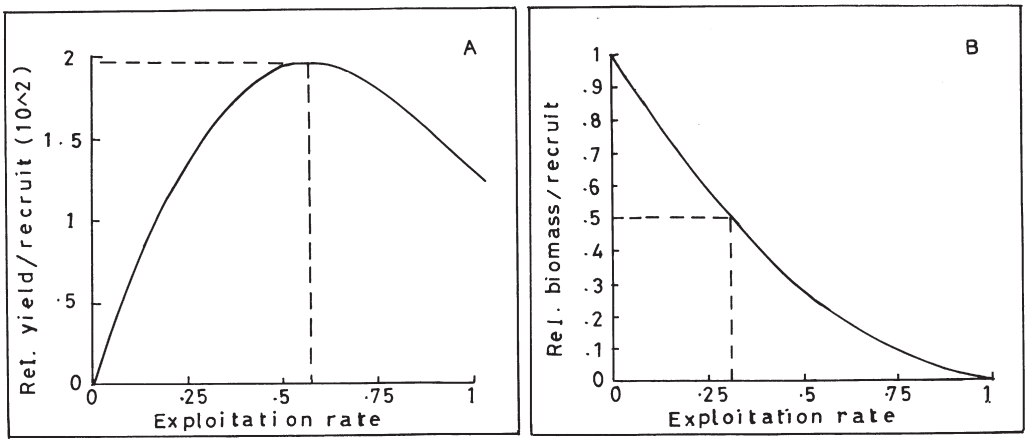

Fig. 5. Yield and biomass per recruit for *J.carutta* exploited by trawls along Visakhapatnam coast during 1994-99 (E_{max} = 0.57 and $E_{0.5}$ =0.31).

Discussion

The catch and the contribution of the sciaenids to the total trawl landings declined compared to 1980's. Luther *et al.* (1988) reported an average annual catch of 502 t with 7.9 % contribution to the total landings. The decrease in catch may be because of the over exploitation of the resource. The seasonal abundance of sciaenids recorded during July-December, did not vary from the earlier reports by Rao *et al.* (1992) (July-September); Rao (1978) (October-December) and Luther *et al.* (1988) (September – December). With regard to the species composition, Rao (1978) observed the abundance of *J. carutta* and *Pseudosciaena aneus* off Andhra and Orissa coast. Murty (1984) reported the dominance of *J. carutta* off Kakinada. The dominance of *A. nibe, J. carutta* and *J. vogleri* in Andhra Pradesh was reported by Rao *et al.* (1992). Chakraborty *et al.* (2000) reported the dominance of *J. catutta, N. maculata* and *K. axillaris* off Visakhapatnam. In the present study *N. maculata, J. carutta* and *P. macrophthalmus* dominated the fishery. This shows that though the species composition has changed over the years, *J. carutta* maintained its dominance for the past 20 years.

The size at first maturity of 154 mm recorded for *J. carutta* agree with the size of 155 mm reported by Murty (1988) and Rao *et al.* (1992) off Andhra coast and 155 mm by Chakraborty *et al.* (2000) off Visakhapatnam. The age at which the fish attained maturity in the present study was 1.8 years while 1.42 years was reported by them. The growth rate in the present study is low compared to that of earlier studies. The length weight relationship obtained for the species was in agreement with the earlier established relationships (Rao, 1983; Murty, 1984).

The studies on the spawning habits of sciaenids showed that the spawning period in majority of sciaenids is not prolonged but restricted to a brief period, only once in a year particularly during the pre-monsoon season along the east coast (Rao *et al.*, 1992). *J. carutta* spawned during January – April (Rao, 1967) and January-April (Chakraborty *et al.*, 2000) off Visakhapatnam; January - June (Murty, 1984) off Kakinada and June – July (Vivekanandan, 1985) off

Madras. In the present study, the spawning season of *J. carutta* was during March – May, which is in agreement with the earlier reports.

The L_∞ and K for *J. carutta* reported by the earlier workers on the east coast (Murty, 1984; Vivekanandan, 1985; Rao *et al.*, 1992; Chakraborty *et al.*, 2000) ranged between 281-333.3 and 0.44-0.725 mm. Though L_∞ obtained in the present study was within the range, the growth constant was less than the minimum value of 0.44 reported. This shows that the growth rate of the species has slowed down. The total mortality rate (Z) of 3.02 obtained in the present study was lower than 5.0748 reported by Murty (1984) and 3.7 by Chakraborty *et al*. (2000) from Kakinada and Visakhapatnam, respectively.

The exploitation rate (E) of 0.68 is above the E_{max} of 0.57 at which rate the maximum yield can be obtained. The exploitation rate can be stabilized between 0.31-0.57 by reducing the effort.

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