Indian J. Fish., 55(4) : 295-299, 2008

Biology and stock assessment of *Tachysurus jella* (Day) from Mumbai waters

S. G. RAJE, A. P. DINESHBABU* AND THAKUR DAS
Mumbai Research Centre of Central Marine Fisheries Research Institute, Mumbai - 400 001, India
**Mangalore Research Centre of Central Marine Fisheries Research Institute, Mangalore - 575 001, India*
e-mail: sgraje@yahoo.co.in

ABSTRACT

Biological parameters such as length-composition, food and feeding, length-weight relations and growth of *Tachysurus jella* was studied using the data collected during 1987-2003. The occurrence of empty stomach was high (70%). Stomach content analysis revealed that the fish is a carnivore feeding mainly on bottom dwelling crustaceans (Preponderance Index, PI : 97.3) such as *Squilla* spp. (PI: 39) and crabs (PI: 35). The length-weight relationship was Log W = -5.7938 + 3.4426 Log L (r = 0.96). Estimated values of L_∞ and K were 518 mm and 0.65yr^{-1} respectively. It was estimated that *T. jella* reaches 278 mm at the end of one year and 377 mm in two years. The longevity was estimated to be 4 to 4 ½ years. Stock assessment of *T. jella* during 1987-1999 indicated that the stock was overexploited (E = 0.73). Higher fishing effort and sharp reduction in yield during 2000 - 2004 confirmed that the species was under heavy fishing pressure and regulatory measures have to be imposed to sustain and improve the fishery of this species.

Introduction

Tachysurus jella contributed 2.7–5.3% of the catfish landings by trawlers at Mumbai during 1991-2004. Though less in quantity, the species occur regularly in the coast and has good demand. The fishery of the species has been reported by Suseelan and Somasekharan Nair (1969). Devanesan and Chidambaram (1953), Rao (1964) and Suseelan and Somasekharan Nair (1969) have given brief accounts on its food items. Chidambaram (1941) has made observation on the development of *Arius jella* (Day). Published information is not available on the growth and population dynamics of *T. jella* from Indian waters and the present study deals with some aspects of biology, growth, mortality and stock assessment of *T. jella* in Mumbai waters.

Materials and methods

Biological data on *T. jella* were collected from trawlers landed at New Ferry Wharf during 1987-2003 as and when the specimens were available. A total of 193 fresh specimens were examined for total length (mm), weight (g), sex, maturity stages of females and gut contents. Homogeneity of the sex ratio over the years has been tested using ÷^{2} test. The relative importance of various food items was determined using index of preponderance (Natarajan and Jhingran, 1962). Data on length frequency distribution collected during 1987 to 1999 were used for growth studies. The length frequency data were grouped into 10 mm class interval. Monthly size frequency data were analysed using ELEFAN I module of FiSAT software to get a preliminary estimate of L_∞ and K. By using L_∞ and K derived from ELEFAN I, routine growth was calculated using von Bertalanffy's growth formula after incorporating gear selectivity corrections. To test the growth parameters for their reliability by comparing them with the available growth studies of the same species and with related species in the same family, empirically derived growth performance index (phi prime index, Ö') which is expressed by the equation (Longhurst and Pauly, 1987), $\Phi' = \log_{10} K + 2\log_{10} L_\infty$, was used. Total mortality coefficient (Z) was estimated using length-converted catch curve method of Pauly (1983) and natural mortality coefficient (M) was calculated by Pauly's (1980) empirical formula. For stock assessment, the results of cohort analysis of length-frequency data were used as input for finding the yield and effort relationship in Thompson and Bell model. Since length frequency data were not available from 1999 to 2004 to get the status of present exploitation, catchability coefficient (q) over the period of 1987-1999 period was calculated and from the 'q' value, fishing mortality during the subsequent years were calculated to understand the present status of exploitation (Alagaraja, 1984).

Results and discussion

Feeding intensity

The stomachs were classified based on degree of their distention and amount of food content as active (gorged and full), moderate (3/4 full and ½ full), poor (¼ full and trace) and empty. Empty stomachs occurred in high percentage (70.5) of the total stomachs examined and highest in all the months (Fig.1). The occurrence of high percentage of empty stomachs does not seem to be unusual as similar instances have been observed in other catfishes such as *Osteogeniosus militaris* (Venkataraman, 1960) and *Tachysurus tenuispinis*, *T. caelatus* and *O. militaris* (Raje, 2003; 2006).

Food composition

Crustaceans (PI: 97.3) formed the main constituent of the diet (Table 1). The dominant crustaceans were *Squilla* spp., crabs, *Solenocera* spp., *Nematopalaemon tenuipes*, panaeid prawns and *Acetes* spp., in the order of abundance. Crustaceans were dominant in almost all the months. Fishes such as *Coilia dussumieri* and *Harpodon nehereus* and catfish eggs were also observed in the stomach.

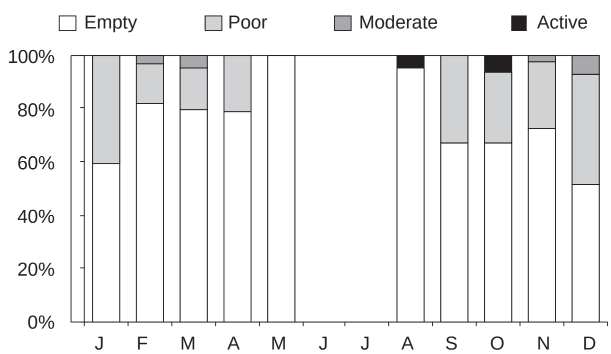

Fig. 1. Monthwise feeding intensity in *T. jella*

T. jella is carnivorous, feeding mostly at the bottom, as evidenced by the occurrence of more than 97% crustaceans with very small quantity of fishes. Devanesan and Chidambaram (1953) observed that *A. jella* feed on molluscs, crabs, prawns, smaller crustaceans and small fishes. Rao (1964) noted that this species is omnivorous and voracious bottom feeder on benthic forms like anemones, polychaetes, crabs, amphipods, anomurans, stomatopods, bivalves and gastropods. Suseelan and Somasekharan Nair (1969) noticed squilla, prawns and bivalve (*Arca* sp.) in the diet.

Alverson (1963) considers that the exoskeleton of crustaceans is digested at a slower rate than fish and remain in the stomach for longer period, thus reducing the percentage of empty stomach. However, it was observed in the present study that although crustaceans formed the main constituent, the percentage of empty stomach was high. Kagwade (1969) also observed high percentage of empty stomachs in the juveniles and adults of *Polynemus heptadactylus*, eventhough crustaceans ranked high in the stomach.

Sex ratio and maturity condition

The male to female sex ratio was 49:51. Monthly sex ratio showed predominance of females during January, May, August and October-December. *Chi* square test conducted to test homogeneity of sexes in the population revealed that the proportion did not vary significantly from 1:1 ratio. Mojumder (1978) also reported equal distribution of sexes in the commercial catch of *T. thalassinus* from Waltair. High percentage of females in *T. tenuispinis* during most of the months has been recorded by Dan (1977) at Waltair.

The minimum size at first maturity (stage III) in *T. jella* was at 280 mm. Females with maturing condition (stage III and IV) were noticed during May, August, October and November during the entire study period.

Length-weight relationship

For test of significance by anaylysis of covariance (ANCOVA), 89 males (199-425mm) and 94 females (180-

Table 1. Index of preponderance of various food items of *T. jella*.

Food items	Volume (%)	Occurrence (%)	Index of preponderance
Crustaceans:			
Squilla spp.	30.6	22.9	39.4
Crabs	25.5	24.6	35.2
Solenocera spp.	15.2	19.7	16.8
Nematopalaemon tenuipes	15.3	6. 6	5.6
Panaeid prawns	1	4.9	0.3
Acetes spp.	1.4	1.6	0.1
Pooled			97.3
Fishes:			
Coilia dussumieri	6.2	4.9	1.7
Harpodon nehereus	1.8	1.6	0.2
Catfish eggs	1.4	1.6	0.1
Fish remains	0.4	3.3	0.1
Pooled			2.1
Digested matter	1.3	8.2	0.6

403mm) of *T. jella* were used. The regression equation for both the sexes were:

Males: Log W = - 5.9240 + 3.3964 (r = 0.96)

Females: Log W = - 5.6952 + 3.3050 (r = 0.97)

As there was no significant difference in regression coefficient of males and females, the data on both the sexes were pooled and a single equation obtained as:

Log W = - 5.7938 + 3.4426 Log L (r = 0.96)

This is in conformity with the finding for the related species *T. thalassinus* (Mojumder, 1972) and *T. tenuispinis* (Dan and Mojumder, 1978) from Waltair.

Growth

Estimated values of L_∞ and K were 518 mm and 0.65yr^{-1} respectively. The growth parameters were tested for their reliability by comparing them with the available growth studies of the same species or with related species in the same family. Growth performance index (Φ') of *T. jella* from Mumbai waters was calculated as 2.34 (Longhurst and Pauly, 1987). By this equation, it was found that values for *T. tenuspinis* from Veraval was 2.53 (Menon *et al*., 1992) and for *T. caelatus* from Bombay waters was 2.38 (Chakraborty *et al*., 1997) which were very close to the present value. By von Bertalanffy's growth formula, it was estimated that *T. jella* reaches 278 mm at the end of one year and 377 mm in two years (Fig. 2) and the longevity is estimated as 4 to 4 ½ years. Development of ovarian maturation was found from a length of 280 mm and it can be assumed that females of *T. jella* mature after completing one year.

Mortality parameters and stock assessment

The total mortality coefficient (Z) estimated for 1987-1999 was 4.36. Natural mortality coefficient values estimated by Pauly's formula (1980) (taking annual average temperature at 28°C) was 1.16. The fishing mortality coefficient (F) was estimated as 3.20 and the exploitation ratio (E) was 0.73, which showed heavy exploitation of the species. The results of the length-converted catch curve method were used for the estimation of probabilities of capture and L_{50} was estimated at 369 mm and L_{75} at 383mm, which were used for recalculation of growth parameters incorporating selectivity of the gear and also for stock assessment studies. Maximum Sustainable Yield (MSY) calculated for the period 1987-1999 (Fig. 3) indicated that during the period, fishery was exploited at F_{max} level (with an average yield of 75 t), which corresponds to average annual fishing effort of 1.23 million hours and further increase in fishing mortality in the form of additional effort will lead to reduction of yield and biomass. Since length frequency data for consequent years were not available, 'catchability coefficient (q)' for 1987-1999 was calculated from average annual fishing mortality and average annual effort (Table 2). Average annual effort (fishing hours), average fishing mortality (F) and 'q' for 1987- 1999 period were 1.28 million, 2.68 and 0.000298 respectively. Considerable increase in the fishing effort (1.38 million to 1.73 million hours) was observed during 2000- 2004 than during 1987-1999 period indicating high fishing mortality for the species (beyond the F_{max} level) and it can be assumed that the species is under heavy fishing pressure.

Considering the sharp reduction in catch in *T. jella* (129 t in 1987 to 37 t in 2003), the exploitation of the species has to be regulated. Reproductive and migratory behaviour of the species has to be studied and exploitation during juvenile phase and during breeding migration has to be stopped to avoid total collapse of this fishery. Menon *et al.* (2000) reported that characteristic reproduction, shoaling

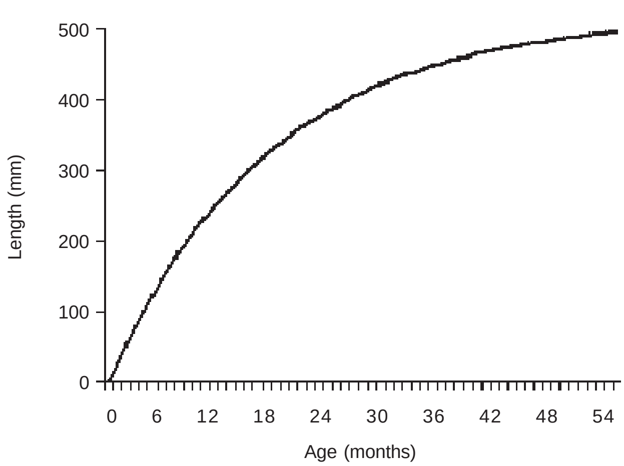

Fig. 2. Estimated growth of *T. jella*

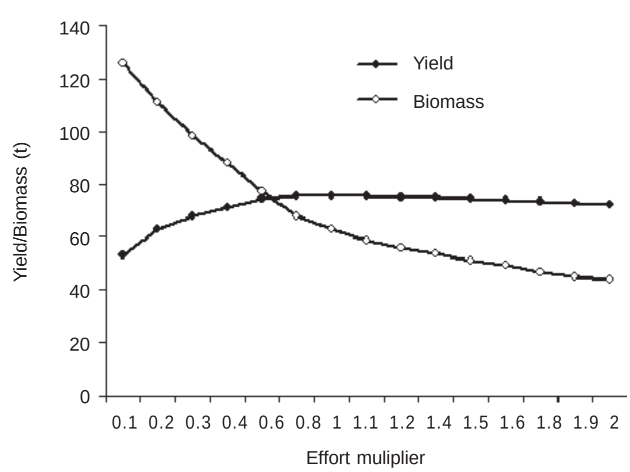

Fig. 3. Results of Thompson and Bell analysis for *T. jella* with length- frequency data for 1987-1999.

Table 2. Mortalities, exploitation rate, catch and effort of *T. jella* during 1987-1999

Year	Total mortality (Z)	Fishing Mortality (F)	Exploitation ratio (E)	Yield (t) (Y)	Effort (in thousand hours)
1987	4.63	3.47	0.75	128	1269
1988	4.61	3.45	0.75	102	976
1989	3.61	2.45	0.68	97	926
1990	5.79	4.63	0.80	44	951
1991	4.97	3.81	0.77	83	1015
1992	5.9	4.74	0.80	86	1224
1993	4.65	3.49	0.75	77	1210
1994	2.98	1.82	0.61	97	1349
1995	3.58	2.42	0.68	91	1534
1996	3.21	2.05	0.64	76	1484
1997	2.58	1.42	0.55	51	1625
1998	1.67	0.51	0.31	57	1450
1999	1.75	0.59	0.34	59	1601
Average		2.68		81	1278

behaviour and migration of many species of marine catfishes made them easy target for overexploitation. Further, 70 % of the specimens analysed had empty stomach. Lakshmi and Rao (1992) noticed damage to catfish fishery largely due to the destruction of the feeding ground of the fish off Visakhapatnam, rather than overfishing. Stock assessment of four species belonging to genus *Tachysurus* was carried out by Alagaraja and Srinath (1987) from Indian waters of which three species *T. tenuispinis*, *T. serratus* and *T. dussumieri* were reported to be under heavy fishing pressure. As observed by Krishnamoorthi (1987) for other catfishes, the present study revealed that the survival and fishery of *T. jella* also depends on the effectiveness of the steps taken to reduce fishing pressure on this resource.

Acknowledgement

The authors are grateful to Prof. (Dr.) Mohan Joseph Modayil, Director, CMFRI and Dr. E. Vivekanandan, Head, Demersal Fisheries Division, CMFRI for their encouragement. The technical assistance of B. B. Chawan is acknowledged. Help rendered by the research scholars, S. Veena, A. K. Anoop and T. Harish Nayak is gratefully acknowledged.

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Date of Receipt : 12-02-07
Date of Acceptance : 02-08-08