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Comparison of the growth of oil sardine *Sardinella longiceps* Val., off Vishakhapatnam and Malabar coasts

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ABSTRACT

The growth of oil sardine, *Sardinella longiceps* off Visakhapatnam and Malabar coast was compared. Hydrological and productivity regimes are found to influence the growth pattern of oil sardine. Growth pattern of oil sardine exhibited seasonality, which was more pronounced along the Malabar coast than off Visakhapatnam.

Introduction

Life history parameters such as L_∞, K , length at first maturity, spawning season *etc.* provide base line information necessary for initial identification of geographical areas representative of individual fish stocks which is necessary for stock assessment studies (Pawson and Jennings, 1996). Although Annigeri *et al*. (1992) have compiled the growth parameters of oil sardine along the west coast of India such information is lacking for the east coast mainly because there was no considerable fishery there until recently. The equation most commonly used in fishery biology to describe length-at age relation is the von Bertalanffy Growth Function (VBGF),

$L_t = L_\infty (1\text{-exp} -K(t-t_0))$. However, growth of pelagic fishes like oil sardine and mackerel have peculiarities which is not explained by the above equation (Yohannan *et al*., 1999) and the use of a seasonalized version of VBGF as given by the equation,

$L_t = L_{\infty} * [1\text{-exp} \{-K(t-t_0) – (C\ K/2\pi) * \sin (2\pi * (t-t_s))\}]$, has been found to considerably improve the fit of a growth curve and the accuracy of the estimated values of growth parameters (Pauly and Gaschuttz,1979). The present study was conducted to estimate the growth parameters of oil sardine using the length frequency data collected from the east coast of India and subsequently compared with earlier studies on the same from the west coast.

Materials and methods

Random samples of oil sardine collected from boat seine units operated along Visakhapatnam coast (17^0 44' N and 83^0 23' E) during 1996-98 were used for the study. The length frequency distribution (in 5 mm intervals) was analysed using ELEFAN module of FiSAT (FAO-ICLARM Stock Assessment Tools Ver.1.1). Initial estimates of L_∞ were obtained using the empirical relationship $L_{max} / 0.95 \sim L_\infty$ (Pauly,1983) and the Powell-Wetherall plot. Growth parameters were then extracted using the automatic search routine of ELEFAN I module. Different combinations of the growth parameters were used as inputs, with and without the seasonality factors (C and WP) and the combination of L_∞, K, C and WP to give the best fitting growth line (maximum R_n value). In the seasonalized VBGF, the K, t_0 and L_∞ are the usual von Bertalanffy parameters, C is a constant which expresses the intensity of growth oscillations and t_s is a constant which expresses time passed between birth (t=0) and the first growth oscillation. It is related to "winter point" (WP) i.e., the time of the year when growth is slowest through the relation $t_s + 0.5 = WP$

Growth parameters thus obtained were related to the observations made on the hydrography of Visakhapatnam coast by Ganapati and Murty (1955) and also compared to the results obtained on the growth of oil sardine off Calicut ($11^0 15'$N and $75^0 49'$E) on the Malabar coast by Yohannan *et al*.(1999). The rate of change in length owing to the seasonal growth factor (SF) was obtained using the following equation (Morgan, 1985):

$SF = L_\infty$ {[CK exp (CK/2 π) sin 2 π ($t-t_0$)]* cos 2 π ($t-t_s$) } and plotted against the time of year. Primary productivity and seasonal growth rates of oil sardine for both the coasts were standardized by subtracting the means of each variable from each individual value and dividing by its standard deviation.

Results and discussion

The estimates of L_∞ obtained by the Gulland and Holt plot, Powell-Wetherall plot and Pauly's (1983) empirical relationship were 211.3, 218.1 and 216.0 mm respectively. The ELEFAN 1 technique gave the best fitting growth line with the following growth parameters of $L_\infty = 216$ mm , K= 1.5 yr^{-1}, C= 0.04 and WP= 0.6 (Rn value = 0.144). Yohannan *et al.*(1999) obtained values of $L_\infty = 200$ mm , K= 2.1 yr^{-1}, C= 0.6 and WP= 0.0 for oil sardine inhabiting the Malabar upwelling zone of the west coast. Seasonality factor (C) was higher (0.6) along the west coast compared to the east coast (0.04)(Fig.1). Observations on the length at age of oil sardine of the west coast by various authors and the results of the present study on oil sardine of the east coast is given in Table1. Standardized annual trend of primary productivity showed distinctly different

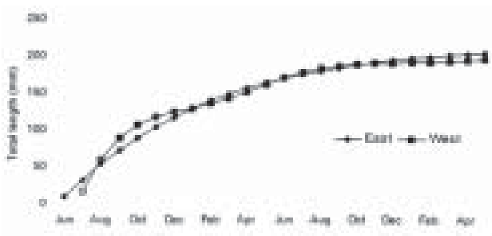

Fig.1. The growth curve of oil sardine along the east and west coast of India using their respective growth parameter sets. L∞ =200 mm , K= 2.1 yr-1, C= 0.6 (Calicut,west coast) and L∞ =216 mm, K= 1.5 yr-1, C= 0.04 (Visakhapatnam, east coast)

TABLE 1: *The length at age of oil sardine on the east and west coast of India*

Area	Length(mm) at age (years)			
	I	II	II	Author
West Coast	150	160	-	Hornell and Nayudu (1924)
	150	178	-	Antony Raja (1970)
	176	197	200	Yohannan *et al.* (1999)
Visakhapatnam	168	205	214	Present study

patterns in the two coastal regions (Fig.2). The rate of change in length due to the seasonal growth factor (SF) plotted against the time of year indicated the growth rate to be lowest during the April to October period along the east coast and October to March along the west coast (Fig.3).

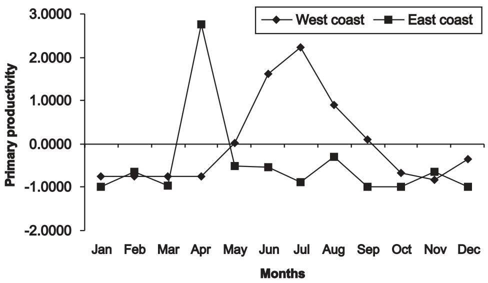

Fig. 2. Primary productivity trends (standardized) of coastal waters of Visakhapatnam (East) and Malabar (West) coasts of India (*Data Source: George, 1953* and *Ganapati and Murthy,1955*)

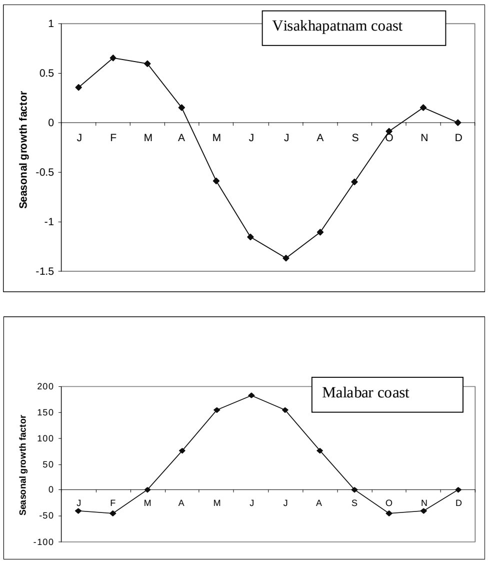

Fig.3. Rate of growth in length of oil sardine as a result of the seasonality factor in the growth equation plotted against the time of year for Visakhapatnam and Malabar coasts of India.

Craig (1999) observed that tropical fishes attain most of their adult size very early in life, with as much as 70-80 % of the growth occurring during the first year. Yohannan *et al*. (1999) observed oil sardine to attain 72% of its potential size in a seven month period, while Hornell and Nayudu (1924) observed that adult size is attained at the age of one year when they measure 155 –170 mm and during the second year growth is extremely slow amounting to 10 mm only. The results of the present study agree with the above observations.

In the present study, the annual trend of environmental variables was taken from earlier studies. Dwivedi (1993), studying the long term variability of the Bay of Bengal ecosystem found that the oceanographic parameters like oxygen, temperature, nutrients and primary productivity did not indicate any significant changes during the last four decades, while Yohannan and Abdurahiman (1998) found that in the Arabian sea the general pattern of changing environment is repetitive year after year although with varying intensities. Therefore the annual monthly hydrography data used in the present study (George, 1953; Ganapati and Murthy, 1955) was considered as valid at present, which is evidenced from some recent studies also (Vijayakumaran *et al*., 1996; Yohannan *et al*., 1999).

Seasonal variations in the growth of aquatic animals are, at least in part, related to temporal changes in water temperature and seasonal variations in abundance and quality of food (Cloern and Nichols, 1978; Pauly 1983). In tropical seas, upwellings are of great significance to biological productivity because of the high fertility they cause in the euphotic zone and are intimately connected with biological processes in the sea (Subrahmanyan, 1973). In the Arabian sea on the west coast of India the process of upwelling starts in April and reaches a peak by July (Pillai *et al*., 1997, Yohannan *et al*., 1999) while on the east coast the upwelling commences in March and continues throughout April and part of May (La fond, 1954; Vijayakumaran *et al*., 1996) bringing up the nutrient rich sub-surface waters and causing a phytoplankton bloom. Hornell and Nayudu (1924) and George (1953) have observed that off Calicut, the primary phytoplankton maxima is from May-September. Ganapati and Murty (1955) while studying the productivity of the coastal waters of Visakhapatnam (east coast) in relation to hydrological factors, observed the spring phytoplankton maxima during February to April after which phytoplankters became sparse followed by a secondary peak during November (Ganapati and Murthy, 1955;Vijayakumaran *et al*., 1996).

In the present study, the growth pattern of oil sardine was found to vary along the two coasts. This is because the physical factors (upwelling, temperature and primary production) factors influencing growth rate occur at different times of the year. At Calicut (west coast) the rate of growth was highest during May to August period and started declining from September upto March. As observed by Yohannan *et al*. (1999), January to April is the period of low plankton abundance and due to a great decrease in supply of food organisms in inshore waters, growth of pelagic fishes of the upwelling ecosystem virtually ceases. On the east coast, the growth rate was highest during February to April, low during May to October and again high from November onwards following the trends of plankton abundance and productivity.

In the present study, C values in the growth function were higher at Calicut (0.6) compared to Visakhapatnam (0.04). Longhurst and Pauly (1987) observed that the amplitude (C) of seasonal changes in growth rate is related to the rate of change in water temperature between warmer and cooler seasons and availability of food which is itself driven by temperature changes. The deviation in the monthly mean water temperature is around 4 ^{0}C at Visakhapatnam (Ganapati and Murty, 1955) and along the Calicut coast it is around 6^{0}C (Hornell and Nayudu,1924; Yohannan and Abdurahiman,1998).

The study suggest a seasonal growth pattern for oil sardine which is supported by independent observations of other authors regarding primary productivity, temperature and growth conditions for oil sardine in Indian waters. It may therefore be reasonably concluded that seasonal dynamics in climate of the Indian Ocean region markedly influence the hydrology and productivity patterns which in turn influence growth of planktivorous fishes such as oil sardine. Fisheries models used for managing tropical fisheries strongly rely on growth parameter estimates obtained by VBGF which assumes constant environmental conditions, a fact which is not true. Longhurst and Pauly (1987) suggest that these estimates can be improved by incorporation of seasonal growth oscillations which should lead to improved yield models.

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