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Studies on the growth of *Otolithes ruber* (Bloch & Schneider, 1801), *Johnius carutta* Bloch, 1793 and *Pennahia macrophthalmus* (Bleeker, 1850) from Paradeep coast, Orissa, India

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ABSTRACT

The growth parameters of three species of sciaenids *viz*.., *Otolithes ruber, Johnius carutta* and *Pennahia macrophthalmus* from Paradeep coast, Orissa State are reported in the present communication. Employing Bhattacharya-Gulland and Holt plot, the asymptotic length (L_∞) and growth co-efficient have been estimated as 511, 305 and 303 mm and 0.67, 0.84 and 0.86 year^{-1} for *O. ruber, J. carutta* and *P. macrophthalmus* respectively. The ϕ prime ranged from 2.90 – 3.24. The growth parameters estimated in the present investigation were compared with the studies conducted for these three species from different parts of the world.

Keywords: Asymptotic length, Growth coefficient, Growth parameters, *Johnius carutta, Otolithes ruber, Pennahia macrophthalmus*, Sciaenid

Introduction

The fishes of the family sciaenidae, commonly known as croakers or jew fishes are widely distributed in different parts of the world, particularly in the tropical and sub-tropical waters of Indian (Druzhinin,1971), Atlantic (Longhurst, 1964, Lowe-McConnel, 1966) and Pacific Oceans (Skajesberg, 1939). These species are recorded in small to moderately large size range, even more than a meter in length and are primarily coastal, though some are distributed in the estuarine waters, even upto a depth of 350 m. Nearly 45 species of sciaenids have been reported from India and adjacent waters (Druzhinin, 1971). However, Mohan (1991) has revised the same and has reported 48 species from the Indian Ocean. Two sciaenid species *viz.*, *Otolithoides biauritus* and *Protonibea diacanthus*, grow to very large size and they command very good price and the swimbladder is also much in demand. The estimated annual average catches of sciaenids during 2000-2009 period in India was around 1,45,062 t which was about 5.34% of the total catch and 20.31% of the demersal catch of India (Anon, 2000-2009). The states of Gujarat, Maharashtra, West Bengal, Tamil Nadu, Orissa, Andhra Pradesh and Kerala dominated in scieaenid landings.

Orissa with a coastline of 480 km has a continental shelf area of 2400 km^2. The potential yield of the state has been estimated around 77,000 t and includes groups like sciaenids, catfishes, pomfrets, ribbon fish, eels, seerfish *etc*. (Sudarsan *et al.,* 1990). The average catch of sciaenids in Orissa during 2001-2002 to 2009-2010 was12,188 t contributing 9.09% of the total marine fish catch.

Determination of age and growth of a fish population is very important in fishery management. It helps to understand the composition of fish population; role of a particular brood or age group in fluctuation of catch and the length /age at capture and maturity. As the three species of sciaenids *viz.*, *Otolithes ruber*, *Johnius carutta* and *Pennahia macropthalmus* happen to be the major contributors to the sciaenid fishery in Orissa, the present investigation on their growth studies was undertaken. *O. ruber* grows to a maximum size of 50 cm while the latter two species reach a size of 30 cm. The growth and other parameters of *O.ruber* have been investigated from Philippines, Mozambique, South Africa and Kuwait by Morgan (1984), Ingles and Pauly (1984), Gislason (1985), Schultz (1992), Brash and Fennessy (2005) and Almatar (1993). In India, studies on this species have been carried out from Tuticorin, Madras and Cochin by Rao *et al.* (1992) and Chakraborty *et al.* (2000).

Investigations on *J. carutta* have been undertaken by Murty (1979, 1985, 1986); Vivekanandan (1985); Rao *et al.* (1992) and Rajkumar *et al.* (2004) from Kakinada, Madras and Vishakapatnam waters along the east coast of India. Observations on age and growth of *P. macropthalmus* have been reported from India (Chakraborty, 1996; Chakraborty *et al.,* 1994, 1996, 2000; Jayasankar, 1995), Philippines (Ziegler, 1979; Ingles and Pauly, 1984) as well as from Malaysia (Abu Talib, 1988).

Materials and methods

Weekly observations were carried out at Paradeep Landing Centre, Orissa from January, 2001 to August, 2002. The length frequency data of the three species were collected at the landing centre itself. The samples thus measured were weighed at the landing centre and the total catch of sciaenids and also of these three species were noted on the day of observation. The length frequency data was distributed in 10 mm class intervals for the study of growth and the sample was raised for the day and subsequently for the month following the method of Sekharan (1962). The von Bertalanffy's (1938) equation was used for the study of growth which is given as:

$$L_t = L_\infty (1- [e^{-K (t-to))}]$$

For the study of growth, the Bhattacharya's (1967) method of modal progression analysis was also used. After separating the mean length from the normal distributions they were connected over a period of time for the estimation of growth. This method was used employing FiSAT programme developed by Gayanilo *et al.* (1995). The data thus generated from modal progression and the estimation of asymptotic length (L_∞) and growth coefficient (K), were further refined by Gulland and Holt's (1959) plot. The K and L_∞ is obtained from K=-b and L_∞ = - a/b. The third parameter of VBGF, the t_0 was estimated by Bertalanffy's plot (1934) which gives an estimate of K and t_o by regression of age t against ln (1 – Lt / L_∞), where slope b= K and t_o = - a/b. The phi prime was estimated following Munro and Pauly (1983) by the formula given as:

$$\phi = \ln K + 2 * \ln L_\infty$$

The t_{max} was determined using the inverse von Bertalanffy's equation given as:

$$t_{max} = t_o - 1/K * \ln (1-Lt/ L_\infty)$$

Results and discussion

Employing the Bhattacharya's (1967) modal progression analysis, eight cohorts could be connected by separating the mean length from the normal distribution. The L_∞ and K for *O. ruber* was estimated as 511 mm and 0.67/year. The correlation co-efficient of 0.5488 was fairly good. These parameters were further refined by Gulland and Holt's plot and the L_∞ and K were estimated as 510.91 mm and 0.67^{-yr} respectively (Fig. 1 and 2). The correlation co-efficient estimated was 0.6197. Using von Bertalanffy's plot the t_o was estimated as -0.019295 years. The von Bertalanffy's growth formula (VBGF) could be written as:

$$L_t = 511 [1 - e^{-0.67 (t- (+0.019295))}]$$

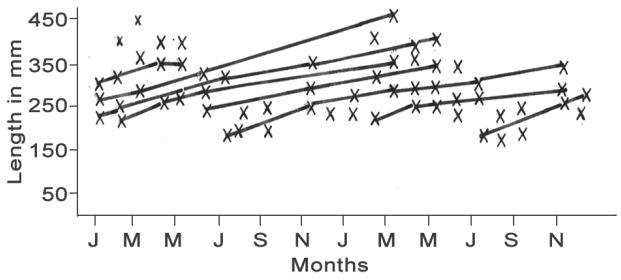

Fig. 1. Linking of means for *O. ruber* employing Bhattacharya method

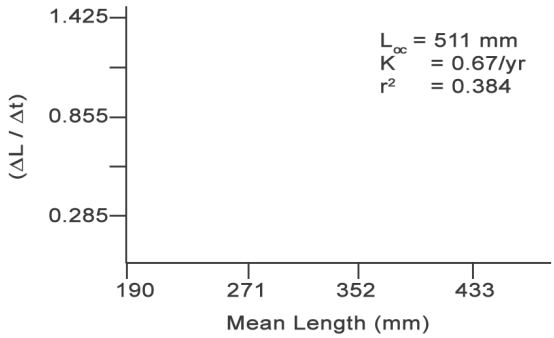

Fig. 2. Gulland and Holt's plot for *O. ruber*

Using this formula it appears the fish grows to 253, 379, 443 and 476 mm at the end of 1, 2, 3 and 4 years of its life span respectively. The largest size of the fish recorded in the catch was 484 mm. Employing inverse VBGF, t_{max} was estimated as 4.39 year and this could be considered as the fishable life span of the species.

For *J. carutta,* employing Bhattacharya's (1967) method a total of six cohorts could be separated from the overall distribution and the L_∞ and K were obtained as 308.76 mm and 0.89^{-yr} respectively. The r was rather poor at 0.3967. Employing Gulland and Holt's plot, the L_∞ was estimated as 305 mm and K as 0.84^{-yr}. The correlation coefficient was better at 0.6308 (Fig. 3 and 4). The t_o was calculated as - 0.010515 years. The von Bertalanffy's growth formula for this species could be written as:

$$L_t = 305 [1 - e^{-0.84 (t- (-0.010515))}]$$

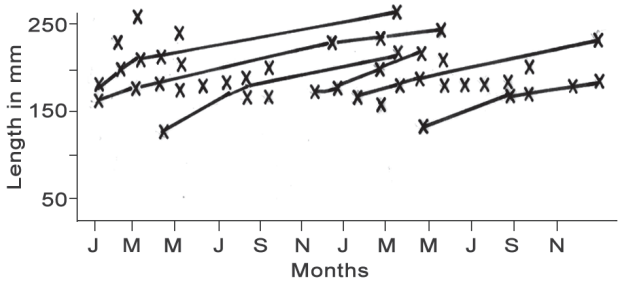

Fig 3. Linking of means for *J. carutta* employing Bhattacharya method

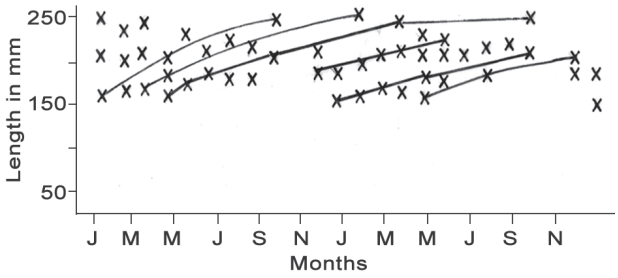

Fig. 5. Linking of means for *P. macrophthalmus* employing Bhattacharya method

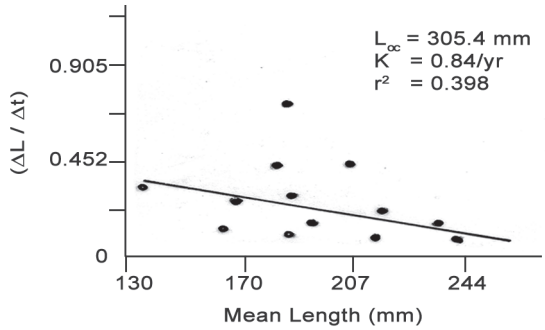

Fig. 4. Gulland and Holt's plot for *J. carutta*

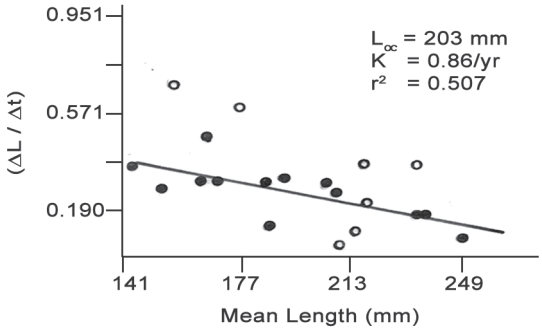

Fig. 6. Gulland and Holt's plot for *P. macrophthalmus*

J. carutta grows to 174, 249 and 281 mm at the end of 1, 2 and 3 years of its life span respectively. The maximum size recorded for this species in the catch was 284 mm. Using the inverse VBGF, the age of this sized fish was calculated as 3.18 years, which may be considered as the fishable life span of this species.

For *P. macrophthalmus* the L_∞ and K obtained, by Bhattacharya's method were 314 mm and 0.95 year^{-1} with r of 0.5368. By Gulland and Holt's plot the L_∞ was estimated as 303 mm and K as 0.86 year^{-1} (Fig. 5 and 6). These estimates were taken for further calculation. The t_o was calculated as – 0.0050292 years. The von Bertalanffy's equation for this species could thus be written as:

$$L_t = 303\ [1 - e^{-0.86\ (t-\ (-0.0050292))}]$$

The average length obtained at the end of 1, 2 and 3 years of life for this species works out to be 175, 249 and 280 mm respectively. The L_{max} recorded in the catch was 286 mm at which, the t_{max} was calculated as 3.35 years employing the inverse VBGF. The phi-prime obtained for *O. ruber, J. carutta* and *P. macrophthalmus* were 3.24, 2.93 and 2.97 respectively.

Distribution of *O. ruber* seems to be more widespread and perhaps for that reason it has been investigated from various parts of the world (Table 1). The L_∞ of the species in various locations ranged from 295 to 696 mm; K ranged from 0.14 to 0.67 year^{-1} and the phi-prime ranged from 2.42 to 3.39. In the present investigation, the L_∞, K and phi prime (ϕ) were estimated as 511 mm, 0.67 year^{-1} and 3.24.

Table 1. Growth parameters estimated for *O. ruber* by various authors for different localities

L_∞ (mm)	K year^{-1}	ϕ	Geographical area	Author
590	0.39	3.13	Kuwait	Morgan (1984)
459	0.14	2.42	Sofala Bank, Mozambique	Gislason (1985)
429	0.32	2.83	Sofala Bank, Mozambique	Schultz (1992)
696	0.50	3.39	Kuwait	Almatar (1993)
469	0.47	3.01	Tuticorin, India	Chakraborty *et al*. (2000)
315	0.65	2.80	Madras, India	Chakraborty *et al*. (2000)
315	0.67	2.82	Cochin, India	Chakraborty *et al*. (2000)
295	0.45	2.60	San Migual Bay, Philippines	Ingles and Pauly (1984)
355	0.43	2.73	Philippines	Ingles and Pauly (1984)
419	0.31	2.73	KwaZulu-Natal, South Africa	Brash and Fennessy (2005)
511	0.67	3.24	Paradeep, India	Present study

J. carutta has a restricted distribution and is more abundant in the east coast of India. In India it has been investigated upon from Madras by Vivekanandan (1985) and from Kakinada by Murty (1979, 1985, 1986) and Rao *et al*. (1992); Chakraborty *et al.* (2000) and Rajkumar *et al.* (2004). L_∞ ranged from 259 - 333.3 mm and K from 0.40 - 0.87 year^{-1} (Table 2). Similarly the phi-prime varied from 2.54-2.90. In the present investigation, the estimate of L_∞ and K is slightly on the higher side, 305 mm and 0.84 year^{-1} respectively. The L_{max} recorded during this period was 284 mm which makes the estimate of L_∞ (305 mm) reasonable. Murty (1986) estimated L_∞ as 333.3, however the largest fish recorded by him was 250 mm only.

Table 2. Growth parameters estimated for *J. carutta* by various authors for different localities in India

L_∞ (mm)	K year^{-1}	ϕ	Geographical area	Author
281	0.557	2.64	Kakinada	Murty (1985)
333.3	0.44	2.68	Kakinada	Murty (1986)
293	0.51	2.64	Madras	Rao *et al.* (1992)
281	0.56	2.64	Visakhapatnam	Chakraborty *et al.* (2000)
295	0.40	2.54	Visakhapatnam	Rajkumar, *et al.* (2004)
305	0.84	2.90	Paradeep	Present study

P. macrophthalmus has been investigated from both the west and east coast of India and also from the Philippines and Malaysian waters (Table 3). Both L_∞ and K shows a wide range of fluctuations, *i.e.*, 185 - 342 mm and 0.40 - 1.94 year^{-1}. The phi-prime (ϕ) ranged from 2.28 - 3.16.

Table 3. Growth parameters estimated for *P. macropthalmus* by various authors for different localities

L_∞ (mm)	K year^{-1}	ϕ	Geographical area	Author
200	0.60	2.28	San Miguel Bay, Philippines	Ingles and Pauly (1984)
265	1.40	2.99	Manila Bay, Philippines	Ingles and Pauly (1984); Ziegler (1979)
342	0.40	2.67	Penang and Perak, Malaysia	Abu Talib (1988)
245	0.64	2.58	Bombay, India	Chakraborty *et al.* (1994; 1997)
260	1.20	2.91	Bombay, India	Chakraborty (1996)
233	1.26	2.84	Rameswaram, India	Jaysankar (1995)
260	0.98	2.82	Mandapam, India	Chakraborty *et al.* (2000)
273	1.94	3.16	Bombay, India	Chakraborty (2001)
303	0.86	2.90	Paradeep, India	Present study

Among the three sciaenid species studied, *O. ruber* is the largest and attains a length of nearly half a meter. Similar observation has been made by Almatar (1993) from Kuwait where he has reported the asymptotic length as 696 mm and Morgan (1984) reported L_∞ of 590 mm from Kuwait waters. The largest fish of 484 mm recorded in the present study justifies higher L_∞ for this species. As not much studies have been carried out on sciaenids from the Orissa coast, this work on the age and growth of the three species of sciaenids would form the basis for further investigations on these resources in future.

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