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Fishery and stock estimates of the silver pomfret, *Pampus argenteus* (Euphrasen), landed by gill netters at Veraval

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ABSTRACT

The fishery and population characteristics of silver pomfret *Pampus argenteus* (Euphrasen) caught by gillnetters off Veraval were studied for the period from 2003 to 2007. The average annual landing of *P. argenteus* was 114.5 t, which contributed 4.5% to the total gill net catches. The period from July to September was the most productive in terms of catch and catch rate. The length–weight relationship showed that the growth was isometric. The sex ratio was 1.75 in favour of females. Mature females occurred throughout the year, with maximum during June – November. The length at first maturity of female was 27.5 cm. The von Bertalanffy growth equation was: $L_t = 41.57\ [1 - e^{-0.64\ (t + 0.0315)}]$. The length at first capture (Lc) was 8.2 cm with recruitment taking place throughout the year with two peaks during February-March and in August. The natural mortality (M), fishing mortality (F) and total mortality (Z) were 1.20, 2.11 and 3.31 respectively. The exploitation ratio (E) was 0.64. The Maximum Sustainable Yield (MSY: 90 t) was lower than the average annual catch indicating over-exploitation of the species. The yield per recruit (Y/R) and biomass per recruit (B/R) was 38.31 g and 18.16 g respectively. An increase in relative yield by 17.18% would be obtained by decreasing the present level of fishing by 60%.

Keywords: Fishery, Gill net catches, *Pampus argenteus*, Population dynamics, Silver Pomfret, Stock assessment

Introduction

The silver pomfret, *Pampus argenteus* (Euphrasen, 1788), is one of the highly priced food fishes along the Saurashtra coast. Silver pomfret contributed on an average 1.7% to the total marine fish landings of Gujarat during 2002–2006 and landings of the species in Gujarat decreased by 27% from 2002 (8000 t) to 2006 (5800 t) (Mohanraj *et al*., 2007). A significant proportion (5%) of the gillnet landings in the state was contributed by silver pomfret while in trawl and dol net catches, it formed only 0.2 – 0.5%. Gill net fishing for silver pomfret is carried out in all the months round the year along Saurashtra coast with peak during July - August.

P. argenteus is an inshore species found in coastal waters from 5 to 100 m depth, usually seen in shoals associated with other demersal fishes over the muddy bottoms. Monofilament bottom drift gill nets consisting of 50 to 80 pieces laced together with varying mesh sizes of 100 – 120 mm and 140 – 160 mm, locally referred to as 'point jal' and 'pankha jal' operate from FRP canoes having 9 – 12 m overall length (OAL) fitted with outboard engines which are actively engaged for pomfret fishing at a depth of 20 – 40 m. The length of each piece is 7 – 8 m.

The fishery and biology of silver pomfret were extensively studied from the Bay of Bengal by Kuthalingam (1963) and Pati (1980; 1982) and from the south-east Arabian Sea by Gopalan (1967). Important publications on the fishery and stock estimates of silver pomfrets of north-west region are those of Khan (1982), Kagwade (1987), Khan *et al*. (1992), Khan (2000) and Sivakami *et al*. (2003). A brief account on the gill net fishery off Veraval by Sulochanan and Rao (1964) and Kasim and Khan (1986) pertain to the fishery that existed about three decades ago. The present paper is a detailed investigation on the current status of the fishery, population characteristics and yield estimates of the silver pomfret caught by gillnetters off Veraval.

Materials and methods

Data on catch and effort expended for *Pampus argenteus* were collected weekly from the gill net landing centres of Veraval for the five-year study period from January 2003 to December 2007. The monthly and annual estimates of catches were made following the procedure adopted by Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute. A total of 7450 specimens of *P. argenteus* in the length range of 6 to

38.9 cm collected randomly each week from Veraval were sampled for recording total length (in cm) and body weight (in grams to 0.01 g precision). The length-weight relationship of *P. argenteus* was calculated following the formula $W=aL^b$ (Le Cren, 1951). The sex ratio was determined from 1100 specimens and Chi-square test performed to test the homogeneity of male and female distribution. The size at first maturity (L_{50}) was determined by plotting the percentage of mature specimens (stage III and above) against the total length. The proportion of gravid and ripe females (V and VI) over time was taken to determine the spawning season.

For estimating the growth parameters *viz.*, asymptotic length (L_α) and growth co-efficient (K), the length measurements of five years' data were pooled month-wise and grouped into 1 cm class interval. Gill net being a selective gear, the length-frequency data were found to be biased as both small and large sized fishes were not caught by this gear. Hence it was adjusted using a selection curve for gill nets (Sparre and Venema, 1998) and resolved into modes and modal progression following Bhattacharya's method and the growth parameters were estimated by Gulland-Holt plot using FiSAT software (Gayanilo *et al*., 1996). The growth performance index, Ø was calculated from the final estimates of L_α and K (Pauly and Munro, 1984). The probability of capture and size at first capture (Lc) were estimated following Pauly (1984) and the age at zero length (t_0) from Pauly's (1979) empirical equation, $\text{Log}(-t_0) = - 0.392 - 0.275 \text{ Log } L_\alpha - 1.038K$. The growth and age were estimated using the von Bertalanffy growth equation, $L_t = L_\alpha(1-e^{-k(t-t0)})$. The mid point of the smallest length group in the catch was taken as length at recruitment (L_r). The recruitment pattern was studied from recruitment curves using final estimated values of L_α, K and t_0. The value of asymptotic weight (W_α) was derived from the value of L_α and the estimated length-weight relationship.

Natural mortality (M) was estimated from the empirical formula suggested by Pauly (1980), by taking the mean sea surface temperature as 27 ^{0}C and total mortality (Z) from length converted catch curve (Pauly, 1983) using FiSAT software. Fishing mortality (F) was estimated as F = Z - M. Length structured virtual population analysis (VPA) of FiSAT was used to obtain fishing mortalities per length class. Exploitation ratio was estimated from the equation, E = F/Z and exploitation rate from $U = F/Z*(1-e^{-z})$; where, F is the fishing mortality rate.

Total stock (P) and biomass (B) were estimated from the ratios Y/U and Y/F respectively; where, Y is the annual average yield in tonnes. Maximum sustainable yield (MSY) was estimated by the equation (Gulland, 1979) for the exploited fish stocks, MSY = Z*0.5*B. The relative yield per recruit (Y'/R) and biomass per recruit (B'/R) at different levels of F were estimated using LFSA package (Sparre,1987).

Results

Fishery

The average annual catch of *Pampus argenteus* for the period 2003 – 2007 was 114.5 t, which contributed 4.5% to the total gill net catches at Veraval. The annual catch fluctuated between 56.6 t in 2007 and 182.1 t in 2006 (Fig. 1). The effort in terms of operated gill net units exhibited a gradual decrease from 20,149 units in 2003 to 13,256 units in 2005 before increasing sharply to 35,756 and 26,291 units in 2006 and 2007, respectively. The catch rate (CPUE) fluctuated widely over the years with the maximum of 8.3 kg unit^{-1} in 2004 and the minimum of 2.2 kg unit^{-1} in 2007. The average catch rate during the period was 5.1 kg unit^{-1}. The percentage contribution of *P. argenteus* to total gillnet catch also fluctuated between 1.0% (2007) to 22.8% (2004).

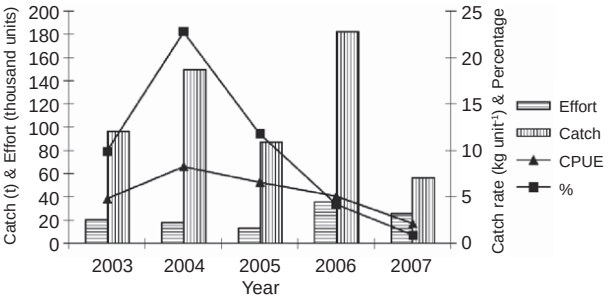

Fig. 1. Trend in fishery of silver pomfret landed by gill net units at Veraval (2003 – 2007)

Seasonal abundance

The monthly gill net catch was highest during the post-monsoon months from September to December and lowest in the monsoon months from June to August. The analysis showed that 72% of the annual catch of *P. argenteus* was during July to September. The average monthly catch and catch rate of *P. argenteus* was highest in August (43.7 t and 35.0 kg unit^{-1}) and lowest in April (1.0 t and 0.4 kg unit^{-1}) (Fig. 2).

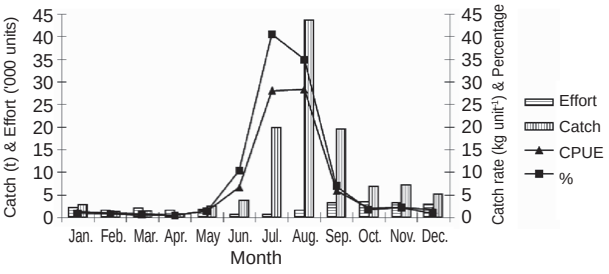

Fig. 2. Seasonal abundance of silver pomfret at Veraval

Length composition

There was no clear trend in the mean length in the catch, which ranged from 22.5 cm (2007) to 26.5 cm (2003). However, the minimum length at capture decreased from 18 cm in 2003 to 6 cm in 2007. More number of larger fishes were encountered during August–October and smaller sizes during March–June (Fig. 3).

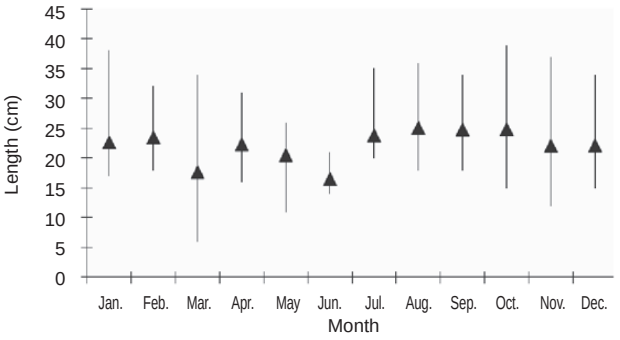

Fig. 3. Monthly length range and mean length of silver pomfret in the gill net landings at Veraval

Length-weight relationship

A total of 551 specimens in the length range of 14.0–38.9 cm, and weight range of 50–840 g were used for determining the length-weight relationship. The relationship obtained is as follows: log W = -1.8052 + 3.050426 log L (r = 0.92).

Sex Ratio

Females dominated and outnumbered the males in the catches throughout the year with an overall sex ratio of 1.75. The chi-square values indicated significant (5%) dominance by females in the months of March, May, June, July and November.

Size at first maturity and spawning season

A total of 700 female specimens collected during the period were examined for determining the size at first maturity. Gonadal development and sexual maturity was observed to commence from 20.5 cm onwards and *P. argenteus* attained sexual maturity at 27.5 cm total length.

Mature females were recorded throughout the year except in April. This suggests a prolonged spawning season for *P. argenteus*. However, higher abundance was noticed during June–November.

Growth

The growth parameters L_α and K estimated using the Gulland-Holt plot (Fig. 4) were 41.57 cm and 0.64 year^{-1}. The growth performance index, Ø was 3.044 and t_0 was calculated at -0.0315 years. The von Bertalanffy growth equation was: $L_t = 41.57\ [1 - e^{-0.64\ (t + 0.0315)}]$

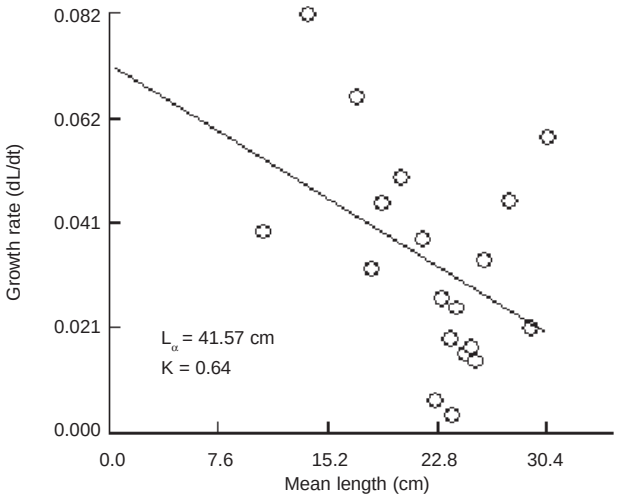

Fig. 4. Beverton-Holt plot for estimating growth parameters of silver pomfret

The relationship showed that the fish attained a size of 20.1 cm, 30.2 cm, 35.6 cm, 38.4 cm and 39.9 cm, respectively by the end of 1, 2, 3, 4 and 5 years. The length at first capture (Lc) was estimated at 8.20 cm, which corresponds to an age (t_c) of 0.31 year. The asymptotic weight (W_α) estimated from the length-weight relationship was 1355.4 g.

Recruitment pattern

The recruitment pattern demonstrated that *P. argenteus* was recruited to the fishery in all months of the year with two peaks during February-March and in August. The smallest length of recruitment was 6.5 cm.

Mortality, exploitation and Virtual Population Analysis (VPA)

The mortality rates M, F and Z were 1.20, 2.11 and 3.31, respectively. The rate of exploitation of *P. argenteus* was 0.614. The exploitation ratio was 0.64, which was higher than the E_{max} of 0.448 obtained from the selection curve, indicating over-exploitation of this species.

The VPA (Fig. 5) indicated that up to 23.5 cm size, natural mortality was higher than fishing mortality. Fishes became more vulnerable to the gear after this size and fishing mortality exceeded natural mortality. The mean value for fishing mortality was 0.97. The maximum fishing mortality of 2.67 was recorded at 33.5 cm length.

Estimation of stock and MSY

The annual total stock, biomass and MSY of *P. argenteus* were estimated at 186 t, 54 t and 90 t, respectively.

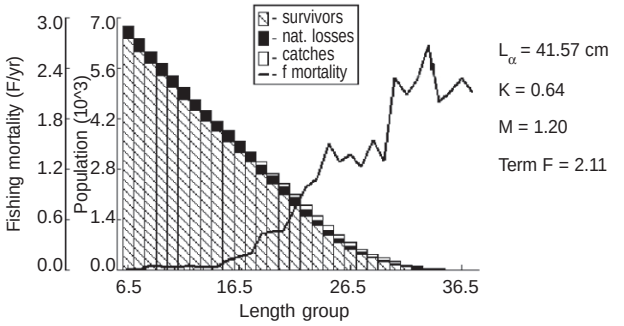

Fig. 5. Length structured VPA for *Pampus argenteus* for the years 2003 - 2007

Yield/recruit

The yield and biomass/recruit and yield and biomass curves showed that the maximum yield and yield/recruit were obtained by decreasing the present effort of fishing by 60% (Fig. 6 and 7). The maximum yield and yield per recruit that can be obtained at the reduced fishing effort is 134 t and 44.89 g, respectively. At the present level of fishing, it is 114.5 t and 38.31 g. The biomass and biomass per recruit achieved at 40% of the present effort is 159 t and 53.19 g, respectively but with the present rate, the biomass and biomass per recruit is a very lowly 54 t and 18.16 g (Fig. 6 and 7). So to get optimum yield and biomass per recruit, the present fishing effort has to be reduced by 60%.

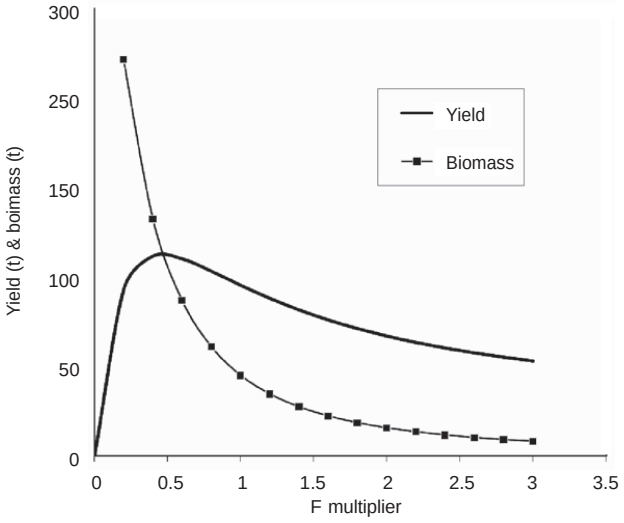

Fig. 6. Thompson and Bell plot for yield and biomass prediction for *Pampus argenteus* with different effort levels

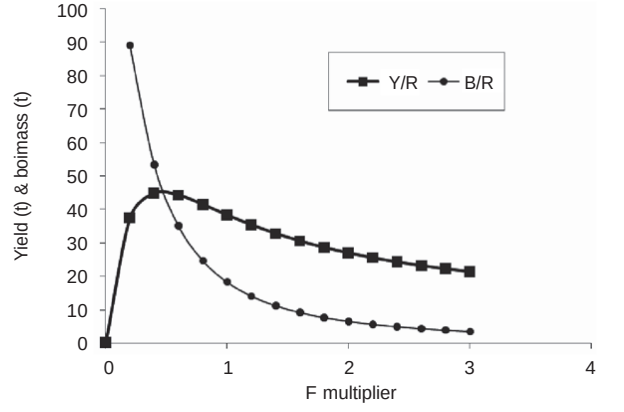

Fig. 7. Yield per recruit and biomass per recruit of *Pampus argenteus* for different multiples of F

Discussion

In Gujarat, there is a total ban on the fishing activities from the middle of June to middle of August by the state fisheries department when fishing is suspended coinciding with the monsoon. In spite of such a ban, artisanal fishermen go for fishing to nearby coastal waters of 20 – 35 m depth for their daily sustenance. Their targeted resource fish is the silver pomfret as during monsoon period, pomfrets undertake spawning migration to their breeding and nursery grounds which are shallow coastal waters having muddy-sandy substratum (Pati, 1982). Moreover, the stirring of shallow coastal muddy waters by monsoon rain greatly hamper the visibility of monofilament gill nets to the silver pomfrets and hence they get entangled and gilled very easily. Kasim and Khan (1986) reported that pomfrets were abundant off Veraval during monsoon months. Silver pomfret thus forms a targeted fishery in the monsoon months and the whole fishing effort is directed to its catch alone. This explains the seasonal peak in catch and catch rate during July to September in spite of the reduced overall fishing effort. Three-fourth of the annual silver pomfret catch is contributed during the monsoon period. The frequency of fishing and fishing effort in the monsoon months depends on the severity of the monsoon rains which varies from year to year and so is the variation in the fishing effort and the catch of silver pomfrets. This is the reason for the wide fluctuation in catch and catch rate recorded over the years.

The average annual catch of pomfrets by the gill net units at Veraval has reduced from 330 t (Kasim and Khan, 1986) to 115 t during 2003 – 2007. Silver pomfrets are recruited to the gill net fishery mostly during February-March and August which elucidates their smaller sizes during this period. The reduction in the minimum length at capture over the years could be attributed to the gradual decrease in the mesh size of the gill nets in recent times from 'pankha jal' (140-160 mm) to 'point jal' (100-120 mm). The length-weight relationship showed that *P. argenteus* exhibited isometric growth. The 'b' value of 3.0504 obtained for silver pomfret in the present study compares well with the 'b' value reported from Gujarat waters (3.076), Bay of Bengal (2.929) and from the waters of Korea (3.0) and Kuwait (3.058) by Khan (2000), Mustafa (1999), Lee *et al*. (1992) and Hussain and Abdullah (1977), respectively.

The length at first maturity was 27.5 cm, which was marginally higher than 26.4 cm reported by Dadzie *et al*. (2000). This difference in the size at first maturity is mostly due to the effect of environment on the biology of the fish and their food availability. Dadzie *et al*. (2000) observed mature females in the catch from length of 20.5 cm onwards which exactly matches the findings of the present study. Dadzie *et al*. (2000) and Almatar *et al*. (2004) from Kuwaiti waters reported that this species is a multiple batch spawner with peak spawning from May to October. Pati (1982) from the Bay of Bengal reported that the silver pomfret has a prolonged spawning season with a peak from July to August. The spawning period was prolonged extending from February to August off Orissa (Sivakami *et al*., 2003). The occurrence of gravid and ripe females off Gujarat throughout the year with a peak in June–November indicated that the spawning season was continuous and that the peak spawning was in the post-monsoon period. The availability of juveniles of *P. argenteus* of 20 mm size in abundance during January - March (Khan, 1982) in the dol net catches at Nawabunder lend support to this observation.

The present estimate of L_{α} (41.57 cm) is much higher than 28 cm, 29.8 cm and 30.67 cm reported by Mustafa (1993), Mustafa (1999) and Khan and Latif (1997) respectively from the Bay of Bengal. However, Khan (2000) while assessing the pomfret stock from the Gujarat, Maharashtra and Karnataka coasts reported L_{α} values of 39.5, 39 and 36 cm, respectively which are in close agreement with the present study. The growth coefficient (0.64) recorded in this study was also similar to 0.69 – 0.7 reported by Khan *et al*. (1992) from the same area. The length at first capture (Lc) of 8.20 cm was very low when compared to the length at first maturity (L_{50}) of 27.5 cm indicating that majority of them were caught before they matured and spawned at least once in their life. This indicated stress on spawning stock and could be addressed by enhancing their size and age at exploitation, which meant that increase in mesh size of gears is required to avoid the young fishes. Lower natural mortality values than that of the present study ranging from 0.5 to 1.05 were reported by Lee *et al*. (1992) from the waters of Korea.

MSY being lower than annual catch and a higher exploitation ratio suggests that the stock is under more fishing pressure warranting immediate decrease in fishing effort for optimally exploiting this species. Maximum yield and biomass as well as yield and biomass per recruit were obtained at 40% of the present effort. It is therefore suggested that measures be taken for their judicious exploitation on a sustainable basis by reducing the fishing pressure by 60% so as to bring the catch to the MSY levels.

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References

Almatar, S. M., Lone, K. P., Abu-Rezq, T. S. and Yousef, A. A. 2004. Spawning frequency, fecundity, egg weight and spawning type of silver pomfret, *Pampus argenteus* (Euphrasen) (Stromateidae), in Kuwait waters**.** *J. Appl. Ichthyol*., 20 (3): 176-188.

Dadzie, S., Abou-Seedo, F. and Al-Qattan, E. 2000. The food and feeding habits of the silver pomfret, *Pampus argenteus* (Euphrasen), in Kuwait waters. *J. Appl. Ichthyol*., 16: 61-67.

Gayanilo, F. C. Jr., Sparre, P. and Pauly, D. 1996. The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. *FAO Comp. Infor. Ser. (Fish.)*, 8: 126 pp.

Gopalan, U. K. 1967. Studies on the mortality and spawning of silver pomfret, *Pampus argenteus* (Euphrasen) in the Arabian Sea. *Bull. Nat. Inst. Sci. India*, 38: 785-796.

Gulland, J. A. 1979. *Report of the FAO/UNDP workshop on the fishery resources of the Western Indian Ocean – South Equator.* FAO, Rome, 10FC/DEV/79/, 45: 1-37.

Hussain, N. A. and Abdullah, M. A. S. 1977. The length-weight relationship, spawning season and food habits of six commercial fishes in Kuwaiti waters. *Indian J. Fish*., 24(1/2): 181-194.

Kagwade, P. V. 1987. Pomfret resources along the north-west coast of India. *Proc. Nation. Acad. Sci.*, 220-224.

Kasim, H. M. and Khan, M. Z. 1986. A preliminary account of the gill net fishery off Veraval during 1979-82. *Indian J. Fish.*, 33(2): 155-162.

Khan, M. Z. 1982. A probable nursery ground of silver pomfret *Pampus argenteus* (Euphrasen) off Nawabunder (Gujarat). *Indian J. Fish*., 29 (1&2): 257-261.

Khan, M. Z. 2000. The fishery and resource characteristics of pomfrets. In: Pillai, V. N. and Menon, N. G. (Eds.), *Marine fisheries research and management*. Central Marine Fisheries Research Institute, Cochin, p. 364-373.

Khan, M. Z., Kumaran, M., Jayaprakash, A. A., Scariah, K. S., Desmukh, V. M. and Dhulkhed, M. H. 1992. Stock assessment of Pomfrets off west coast of India. *Indian J. Fish*., 39 (3 & 4): 249-259.

Khan, M. G. and Latif, M. A. 1997. Potentials, constraints and strategies for conservation and management of open brackish water and marine fishery resources, *BOBP Report of the*

National Workshop on Fisheries Resources Development and Management in Bangladesh. The Bay of Bengal Programme, India.

Kuthalingam, M. D. K. 1963. Observations on the fishery and biology of the silver pomfret, *Pampus argenteus* (Euphrasen) from the Bay of Bengal. *Indian J. Fish.*, 10 (1): 59-74.

Le Cren, E. D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol*., 20: 201-219.

Lee, D. W., Kim, Y. M. and Hong, B. Q. 1992. Age and growth of silver pomfret (*Pampus argenteus*) in Korean waters. *Bull. Natl. Fish. Res. Dev. Agency Korea,* 46: 31-40.

Mohanraj, G., Nair, K. V. S., Asokan, P. K. and Ghosh, S. 2007. Status of marine fisheries in Gujarat with strategies for sustainable and responsible fisheries., *Book of Abstracts, 8th Asian Fisheries Forum*, Central Marine Fisheries Research Institute, India, 85 pp.

Mustafa, G. M. 1993. ELEFAN based growth parameters of white pomfret *Pampus argenteus* from the Bay of Bengal. *Bangladesh J. Zool*., 21(1): 143-149.

Mustafa, M. G. 1999. *Population dynamics of penaeid shrimps and demersal finfishes from trawl fishery in the Bay of Bengal and implication for the management*. Ph. D. thesis, University of Dhaka, Bangladesh, 223 pp.

Pati, S. 1980. Food and feeding habits of silver pomfret, *Pampus argenteus* (Euphrasen) from Bay of Bengal with a note on its significance in fishery. *Indian J. Fish.*, 27: 244-256.

Pati, S. 1982. Studies on the maturation, spawning and migration of silver pomfret, *Pampus argenteus* (Euphrasen) from Bay of Bengal. *MATSYA*, 8: 12-22.

Pauly, D. 1979. Theory and management of tropical multi-species stocks. A review with emphasis on the south-east Asian demersal fisheries. *ICLARM Studies and Reviews,* 1: 35 pp.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *L. Cons. Ciem*., 39 (2): 175-192.

Pauly, D. 1983. Length converted catch curves. A powerful tool for fisheries research in tropics (Part-1). *ICLARM Fishbyte*, 1(2): 9-13.

Pauly, D. 1984. Length converted catch curves. A powerful tool for fisheries research in tropics (Part-II). *ICLARM Fishbyte* 2(1): 13-14.

Pauly, D. and Munro, J. L. 1984. Once more, on the composition of growth in fish and invertebrates. *Fishbyte*, 2 (1): 21.

Sivakami, S., Vivekanandan, E., Raje, S. G., Shoba, J. K. and Rajkumar, U. 2003. Lizardfishes, Pomfrets and Bullseye. In: Mohan Joseph, M. and Jayaprakash, A. A (Eds.), *Status of exploited marine fishery resources of India*, CMFRI, Kochi, India, p. 141-157.

Sulochanan, P. and Rao, K. K. 1964. On the vertical distribution of silver pomfret (*Pampus argenteus* Euphrasen) in the bottom drift gill net off Veraval and Porbunder. *Indian J. Fish*., 11: 9-14.

Sparre, P. 1987. Computer programming for fish stock assessment. Length based fish stock assessment (LFSA) for Apple computers. *FAO Fish. Tech. Pap.*, 101 (Suppl 2), 217 pp.

Sparre, P. and Venema, S. C. 1998. Introduction totropical fish stock assessment - Part 1: Manual. *FAO Fish. Tech. Pap.* 306: 185-214.

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