



Age and growth studies in silverbellies along Kerala coast

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Abstract

Age and growth were estimated for five species of silverbellies from samples collected for 24 months from January 1998 along Kerala coast. The estimated values of von Bertalanffy growth parameters are: *Eubleekeri splendens* $L_{\infty} = 154$ mm, $K = 0.52$; *Leiognathus brevisrostris* $L_{\infty} = 140$ mm, $K = 0.86$; *Secutor insidiator* $L_{\infty} = 130$ mm, $K = 0.80$; *S. ruconius* $L_{\infty} = 92$ mm, $K = 1.19$ and *Gazza minuta* $L_{\infty} = 160$ mm, $K = 1.7$. Length-weight relationship of *E. splendens* $W = 0.000006 L^{3.163977}$, *S. insidiator* $W = 0.0000015 L^{3.463096}$ and *S. ruconius* was $W = 0.000162 L^{2.973626}$. The K_n value in *E. splendens* is lowest in the 75-79 mm length group and highest in 100-104 mm length group. In *S. insidiator* the K_n value is highest in the 60-64 mm length group. A review of methods available for study of growth has been made and the limitations are discussed. In the ELEFAN method, which has been followed in the present work, the issues confronted are discussed and the ways by which accurate growth parameters could be estimated are discussed.

Keywords: Population parameters, silverbellies, length-weight relationship, condition factor

Introduction

A sound knowledge of growth and age of species contributing to the fishery is essential for understanding the longevity of exploited stocks, age composition of the catch, age at sexual maturity, suitability of different environments for growth, population dynamics and possible identification of stocks on the basis of differences in growth rates. Estimates on age and growth of Indian silverbellies are available (James and Badrudeen, 1975; Murty 1983, 1986a; Jayabalan and Ramamoorthi, 1986; Jayabalan, 1988; Karthikeyan *et al.*, 1989). In the present study, ELEFAN method using FiSAT package (Gayanilo *et al.*, 1988) has been followed to estimate age and growth of five species of silverbellies off Kerala. The issues confronted in analysis are brought out and the ways by which accurate growth parameters could be estimated, are discussed.

Material and Methods

The analysis was made from the samples collected from January 1998 to December 1999 from

Cochin Fisheries Harbour and Neendakara Fisheries Harbour, which are the major trawl landing centres in Kerala. Since the mechanised trawlers contribute more than 90% to the landings of silverbellies at both these centres, sampling was done only from these units. Sampling was done at weekly intervals from Cochin and at fortnightly intervals from Neendakara. On each sampling day the units to be sampled were selected following Alagaraja (1984).

Length - weight relationship and relative condition factor

The length-weight relationship was calculated in *Eubleekeria splendens* (= *Leiognathus splendens*, recent nomenclature change, Kimura *et al.*, 2008), *Secutor insidiator* and *S. ruconius* following Le Cren (1951) with the help of the equation $\text{Log } W = \text{Log } a + b \text{ Log } L$, where W = total weight of the fish in grams and L is the total length in mm. The relative condition factor (K_n) was calculated as the ratio of observed and calculated weights for each length and the averages of different months in all the length

groups and the averages of different length groups in all the months were considered.

The study is based on length and weight data of 1703 specimens of *E. splendens* (939 females, of the length range 72 mm-115 mm and 663 males of the length range 71 mm-109 mm), 988 specimens of *S. insidiator* (637 females of the length range 63 mm-108 mm and 283 males ranging in length from 80 mm to 106 mm) and 150 specimens of *S. ruconius*, ranging in length from 38 mm to 85 mm, collected during the period from January 1998 to December 2000.

Growth parameters

The data on five species of silverbellies, *E. splendens*, *L. brevisrostris*, *S. insidiator*, *S. ruconius* and *Gazza minuta* (which account for 90% of the total landings of silverbellies in the region) were utilised for estimating growth parameters. Length measurements were taken for 28,550 specimens of *E. splendens* (45 mm-140 mm), 5,474 of *L. brevisrostris* (64 mm-135 mm), 13,284 of *S. insidiator* (51mm- 120 mm), 1,873 of *S. ruconius* (44 mm- 98 mm) and 3,508 specimens of *Gazza minuta* (62 mm-180 mm). The length data were grouped into 5 mm class intervals and weighted to the estimated total catch of the species on the date of observation from Cochin and Neendakara centres separately. The estimated length-frequency distribution in all the sampling days were pooled and then weighted to the estimated total catch of the species from each of the centres. Thus the length-frequency distribution in the estimated catch of a species from Cochin and Neendakara landing centres was obtained. The von Bertalanffy growth parameters were estimated for the two years 'data' from each centre separately. The data of the corresponding months from each centre were pooled and subsequently the data from both the centres were pooled. For this purpose the FiSAT package (Gayanilo *et al.*, 1988) was used.

After arriving at best possible estimates of L_{∞} and K, the routine in the FiSAT package "output of results" was used to find whether the growth curve was passing through the maximum number of modal lengths in the actual length frequency data. The analysis was carried out using different sets of data

until a reasonable, satisfactory value of L_{∞} and its compatible K were obtained. Finally the "best" estimates of L_{∞} and K of all the estimates from different sets of data were taken as representing the growth curve of the species.

L_{∞} represents the maximum length, a species can attain (Gulland, 1983). Since the von Bertalanffy growth curve represents an "average growth curve", the estimated L_{∞} value can be less than the maximum recorded length. Hence, different input values of L_{∞} greater and smaller than the maximum recorded lengths were tried. After arriving at best possible estimates of L_{∞} and K, the routine in the FiSAT package "output of results" was used to see whether the growth curve was passing through the maximum number of modal lengths in the actual length frequency data.

Results and Discussion

Length - weight relationship and relative condition factor

The length-weight relationships were estimated as given below:

$$E. splendens: W = 0.0000060 L^{3.163977}; R^2 = 0.90$$

$$S. insidiator: W = 0.0000015 L^{3.463096}; R^2 = 0.80$$

$$S. ruconius : W = 0.0000162 L^{2.973626}; R^2 = 0.95$$

The average condition factor for each 5 mm length group was calculated and plotted against the respective length groups for *E. splendens* (Fig. 1) and *S. insidiator* (Fig. 2). The monthly average

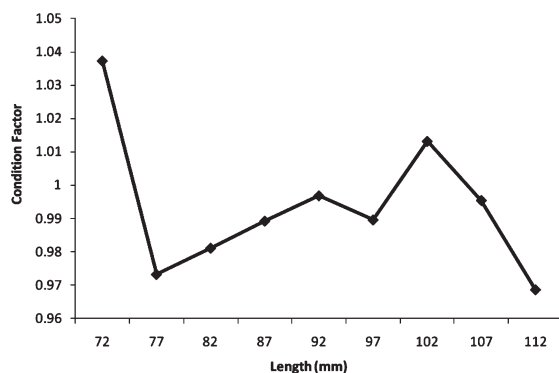


Fig. 1. Condition factor of females in different length ranges in *Eubleekeria splendens*

condition factor for different length groups pooled for the different months from October 1998 to December 1999 for both the species are given in Figures 3 and 4. The K_n value for *E. splendens* is the lowest in the 75-79 mm length group, which corresponds to the length at first maturity for the species (Abraham *et al.*, 2010, MS), and shows the highest value in the 100-104 mm length group. In *S. insidiator* the K_n value is highest in the 60-64 mm length group, and thereafter continues at a low level in all the length groups.

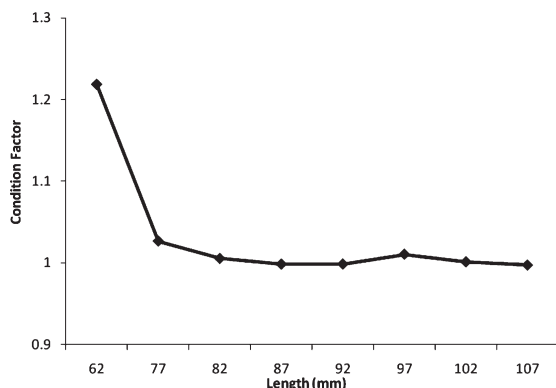


Fig. 2. Condition factor of females in different length ranges in *Secutor insidiator*

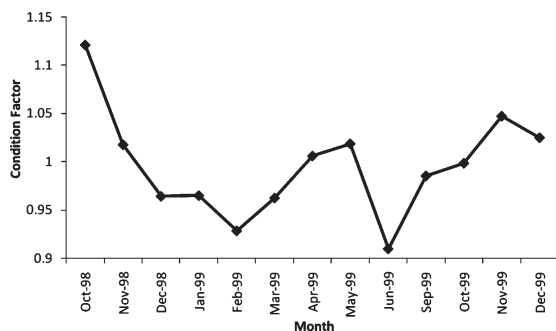


Fig. 3. Condition factor of females in different months in *Eubleekeria splendens*

In *E. splendens*, since the condition factor does not show a correlation with the peak spawning period, no valid conclusions could be reached about its variation between months. In *S. insidiator*, the condition factor shows a high value in March 1999, corresponding to a peak occurrence of mature stages (Abraham *et al.*, 2010, MS) and thereafter shows an irregular pattern.

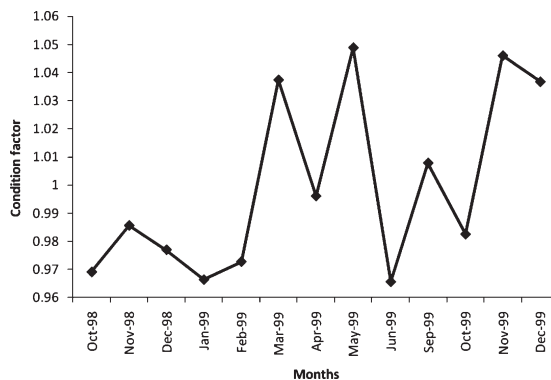


Fig. 4. Condition factor of females in different months in *S. insidiator*

Studies on length-weight relationship in silverbellies are of Arora (1952) on *E. splendens* off Rameswaram, Balan (1963) on *L. bindus* off Calicut, James and Badrudeen (1981) on *L. dussumeri* from Gulf of Mannar, Murty (1983) on *L. bindus* off Kakinada, James (1986) on *L. jonesi* off Palk Bay and Gulf of Mannar, Murty (1986b) on *L. bindus* along the West Bengal coast, Hameed Batcha and Badrudeen (1992) on *L. brevirostris* from Palk Bay, and Jayabalan and Krishna Bhat (1997) on *L. splendens* and *G. minuta* off Parangipettai.

The length-weight relationship in silverbellies determined by earlier authors is given in Table 1. In all the cases the authors analysed the relationship separately for male and female tested the significance of the observed results by analysis of covariance and found that the differences were not statistically significant. Available literature on fishes pertaining to the length-weight relationship of sexes show that they are different only in instances where one sex attains a greater maximum length than the other; in other words there is differential growth rate between sexes in such species (Krishnamoorthi, 1971). In the present study male and female did not show difference in their maximum length. Hence relationship was not calculated separately for the sexes.

Growth Parameters

The estimated values of L_∞ and K of the five species are shown in Table 2 and the von Bertalanffy growth equations (VBGF) are given below:

E. splendens : $L_t=154 (1-e^{-0.52(t-(-0.19))})$ (Fig.5)

L. brevisrostris : $L_t=140 (1-e^{-0.86(t-(-0.0))})$ (Fig.6)

S. insidiator: $L_t=130 (1-e^{-0.80(t-(-0.001))})$ (Fig.7)

S. ruconius: $L_t=92 (1-e^{-1.19(t-(-0.0))})$ (Fig.8)

G. minuta : $L_t=160 (1-e^{-1.70(t-(-0.0))})$ (Fig.9)

The length-at-age of the five species, *E. splendens*, *L. brevisrostris*, *S. insidiator*, *S. ruconius* and *G. minuta* derived from VBGF equation is presented in Figures 10 and 11.

As the von Bertalanffy growth parameters are incorporated in the Beverton and Holt yield equation,

Table 1. Length-weight relationship of different species of silverbellies from India

Length-weight relationship	Species	Reference	Locality	a	b
Log W=-4.8233+3.200 Log L	<i>E. splendens</i>	Arora (1952)	Rameswaram	-4.8233	3.200
Log W=-4.7850+2.959 Log L	<i>L. dussumieri</i>	James and Badrudeen (1981)	Gulf of Mannar	-4.7850	2.959
Log W=-4.7771+2.962 Log L	<i>L. bindus</i>	Murty (1983)	Kakinada	-4.7771	2.961
Log W=-5.3822+3.286 Log L	<i>L. bindus</i>	Murty (1986)	West Bengal	-5.3822	3.286
Log W=-5.2021+3.216 Log L	<i>L. jonesi</i>	James (1986)	Mandapam	-5.2021	3.216
Log W=-4.4769+2.887 Log L	<i>L. jonesi</i>	Karthikeyan et al (1989)	Rameshwaram	-4.4769	2.887
Log W= -5.7371+3.436 Log L	<i>S. insidiator</i>	Murty (1990)	Kakinada	-5.7371	3.436
Log W= -4.8512+3.004 Log L	<i>L. brevisrostris</i>	Hameed Batcha and Badrudeen (1992)	Palk Bay	-4.8512	3.004
Log W= -5.2218+3.163 Log L	<i>E. splendens</i>	Present study	Kerala	-5.2218	3.163
Log W= -5.8239+3.463 Log L	<i>S. insidiator</i>	Present study	Kerala	-5.8239	3.463
Log W= -4.7902+2.973 Log L	<i>S. ruconius</i>	Present study	Kerala	-4.7902	2.973

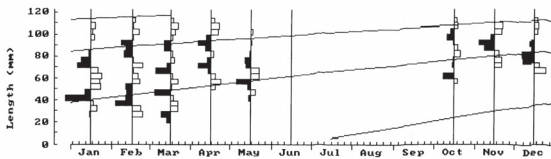


Fig. 5. Restructured growth curve (FiSAT) of *Eubleekeria splendens*

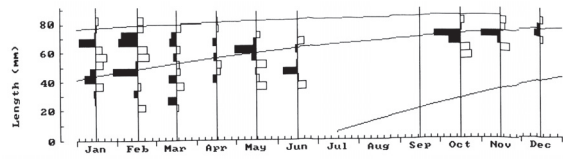


Fig. 8. Restructured growth curve (FiSAT) of *S. ruconius*

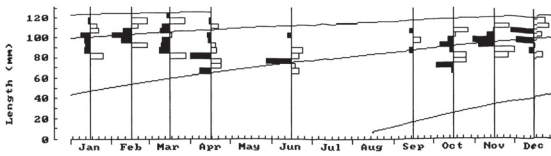


Fig. 6. Restructured growth curve (FiSAT) of *Leiognathus brevisrostris*

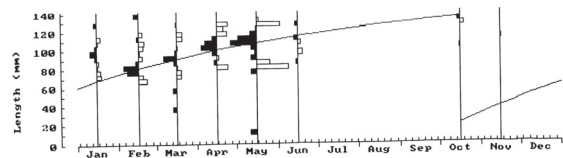


Fig. 9. Restructured growth curve (FiSAT) of *Gazza minuta*

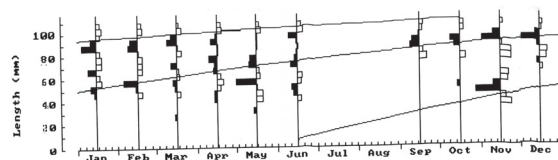


Fig. 7. Restructured growth curve (FiSAT) of *Secutor insidiator*

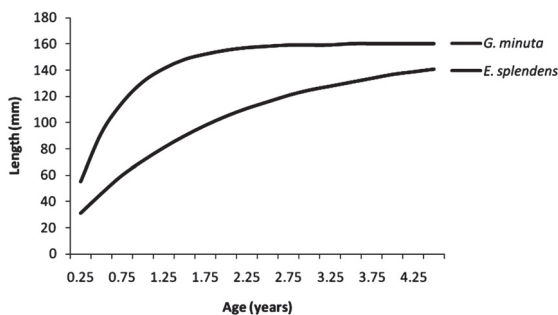
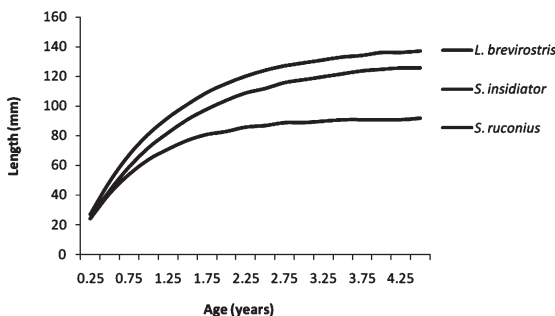
the validity of the yield curve in any exploited species would depend upon the precision of the estimates of growth parameters. This could be best achieved by ensuring adequate samples of landings such that the samples from the landings could be taken as representing the population with respect to length frequency distribution. In the present study while large representative samples were collected on all the observation days, the possible differences in the

Table 2. The estimated values of L_{∞} , K and ϕ for five species of silverbellies along the Kerala coast

Species	L_{∞} (mm)	K (per year)	ϕ^1	t_0
<i>Eubleekeria splendens</i>	154	0.52	4.09	-0.19
<i>Leiognathus brevisrostris</i>	140	0.86	4.23	-0.00
<i>Secutor insidiator</i>	130	0.80	4.13	-0.001
<i>Secutor ruconius</i>	92	1.19		-0.000
<i>Gazza minuta</i>	160	1.70	4.64	-0.00

length composition between different boats landing on the same day were also taken into account.

Though a number of growth curves are developed, the von Bertalanffy (1934) growth curve is used in fish populations because “it fits most of the observed data of fish growth and can be incorporated readily into stock assessment models” (Gulland, 1983). In the present study, the von Bertalanffy growth parameters were estimated using the ELEFAN method. The ELEFAN method poses certain problems while attempting to extract the “best” growth curves. It has been observed during the analysis that several “best” estimates could be made on the basis of a single data set and it becomes increasingly difficult to really “choose” the most reliable set of growth parameters. On several occasions, high and maximum R_n values were obtained at L_{∞} values much higher than L_{\max} values known or much lower than the same whereas one would expect L_{∞} values to be close to the L_{\max} values. As the L_{\max} values known in the literature were taken as seed values initially since the species has the potential to attain lengths close to the L_{\max} , this problem was got over by selecting the growth curves that lead to estimation of L_{∞} close to the L_{\max} ; and the growth curves that pass through maximum number of positive peaks in the restructured length-frequency distribution. The validity of the growth curves chosen was also tested by fitting the growth curve on actual length frequency distribution through the available routine. As this is the first attempt on silverbellies off Kerala coast there was no opportunity to compare similar values from this region. However, considering the frequency and strategy of the sampling, and the care taken in extracting the most reliable values of L_{∞} and K, the estimated values may be considered as reliable.

Fig. 10. Growth curves of *Gazza minuta* and *Eubleekeria splendens*Fig. 11. Growth curves of *Leiognathus brevisrostris*, *Secutor insidiator* and *S. ruconius*

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