Fishery Technology
1998, Vol. 35(2) pp : 114 - 119

Population Dynamics of an Indigenous Carp *(Labeo dussumieri)* of the River Pampa, Kerala (India)

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Based on length composition of commercial landings of *Labeo dussumieri* of the river Pampa, growth parameters, Lα and K were estimated using ELEFAN I programme as 464.7 mm and 0.64/annum respectively in male and 502 mm and 0.81/annum in female. Average instantaneous rates of mortality Z, M and F in male were respectively 1.4305, 0.8595 and 0.5710 while in females the above values were 2.3348, 1.0863 and 1.2485. From the length converted cohort analysis, F was estimated to be 0.5709 in male against 1.2484 in female. The results of the present study showed that males of *L. dussumieri* of the river Pampa are harvested below the optimum level while the females are exploited at optimum level and therefore, it is concluded that the stock of this species can be maintained at a sustainable level at the present level of exploitation.

Key worlds : ***Labeo dussumieri*, growth parameters, mortality rates, stock sizes.**

Labeo dussumieri (Val.) was one of the common food fishes of the river Pampa during early thirties (John, 1936). In recent years its occurrence became sparse and Kurup & Kuriakose (1991) have stated that it required the status and protection of an endangered species. Information on the dynamics of the stock and other related aspects in respect of this species are essential for judicious exploitation and management of this resource. A review of the literature revealed that hitherto no attempt has been made to estimate the growth and mortality parameters and also to assess the stock size and exploitation rate of the population of *L. dussumieri* inhabiting the river Pampa. This paper deals with estimating the growth parameters, mortality, biomass, recruitment pattern and exploitation rate of *L. dussumieri* of the river Pampa based on length frequency data.

Materials and Methods

Materials for the present study were collected from the commercial gear such as gill nets and seines operating in river Pampa at weekly intervals from four fish landing centres during January 1988 to December 1989. The male and female were identified by examining the gonads and the total length was measured from tip of snout to tip of caudal fin using a dial reading calliper. Weight was recorded to the nearest 0.1 g. A total of 1436 males with the total length in the range of 142.8 mm to 454 mm and 1844 females with total length ranging from 153 mm to 458 mm were sampled for length frequency studies. Length-weight relationship was analysed following Le Cren (1951). The length frequency data were grouped sex wise into 20 mm class intervals and sequentially arranged for two years. The growth parameters were

estimated following integrated method of Pauly (1982, 1983) and ELEFAN I (Gayanilo *et al.*, 1996). The Von Bertalanffy growth equation (VBGE) (Bertalanffy, 1938) was used to describe the growth. The equation for growth in length is given by $Lt = L\alpha\ (1\text{-}exp^{-k(t-t_0)})$ where Lt is the length at age t, Lα is the asymptotic length, K is a growth coefficient and 't_0' is the age at which fish would have had zero length if they had always grown according to the above equation. Lengths at three months intervals were obtained from the integrated method of Pauly (Pauly, 1983) and estimates of Lα and K were done using Ford-Walford plot (Ford, 1963; Walford, 1946). Value of 't_0' was estimated by a plot of $\log_e(l_\alpha\text{-}L_t)$ against t'.

The total mortality coefficient (Z) was estimated using the method of Beverton & Holt (1966), the length converted catch curve analysis (Sickle, 1977) and Pauly's Pile up method (Pauly, 1983). Natural mortality coefficient (M) was estimated using Sekharan's method (1975) and Pauly's (1980) empirical formula which is given by $\log_{10} M = 0.0066\text{-}0.279\ \text{Log}_{10}\ L+0.6543\ \log_{10} K+0.4634\ \log_{10}T$ where M is the natural mortality, Lα and K are the parameters of VBGF and T, the annual mean temperature (in °C) of the water in which the stock lives, which was taken as 30°C. The Rikhter & Efanov (1976) method was also used to calculate the natural mortality using the relationship, $M = 1.521\ t_m^{-0.72} - 0.155$ where t_m is the age at which 50% of the population is mature, which was taken as 1.2078 and 1.0063 years in males and females respectively.

Length cohort analysis (Jones, 1984) was used to estimate stock sizes and fishing mortalities. In this analyis the number of fishes in the river that attain L1 is given by

$$N(L_1) = [N(L_2)S(L_1,L_2) + C(L_1,L_2)]\ S\ (L_1, L_2)$$

where

$$S(L_1,L_2) = [(L_\alpha\text{-}L_1)/L_\alpha\text{-}L_2]^{m/2K}$$

The exploitation rate is determined from the relationship, $F/Z = C(L_1, L_2)/[N(L_1) - N(L_2)]$. The fishing mortality was calculated using the formula $F = M(F/Z)/(1\text{-}F/Z)$. In the above expressions Lα and K are growth parameters of VBGE, L_1 and L_2 are lower and upper limits of a length group considered, N is the stock number, C is the number caught and F and M are fishing and natural mortality coefficients respectively.

Results and Discussion

The length-weight relationship in *L. dussumieri* can be expressed as follows: male, $W = 0.000006601\ L^{3.0863}$ and female, $W = 0.00000411\ L^{3.1783}$. The asymptotic length (L_α) and growth coefficient (K) were derived using ELEFAN I programme and the restructured data

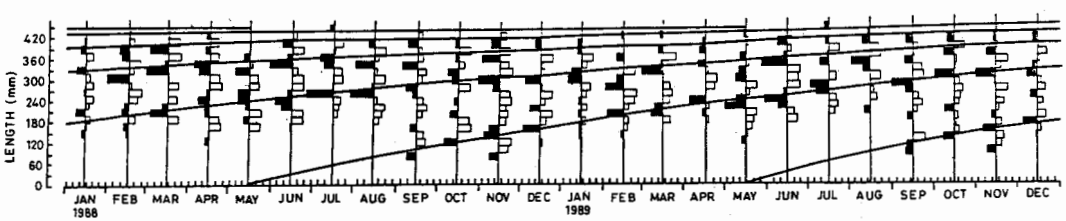

Fig. 1. Growth curve of *Labeo dussumieri* (Male) as estimated using the ELEFAN I Programme (Lα = 464.7 mm and K = 0.64/year)

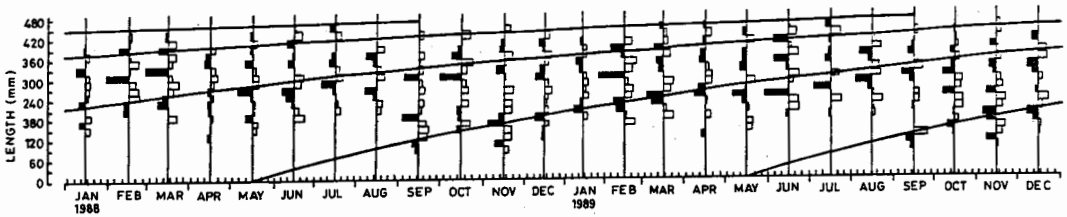

Fig. 2. Growth curve of *Labeo dussumieri* (Female) as estimated using the ELEFAN I Programme (Lα = 502 mm and K = 0.81/year)

with super imposed growth curve fitted with the help of the above growth parameters in male and female of *L. dussumieri* are depicted in Fig. 1 and 2. The growth parameters so obtained for male were L_α = 464.7 mm and K = 0.64/annum and for female, L_α = 502 mm and K = 0.81/annum.

The modal lengths corresponding to various ages at regular time intervals in male and female populations of *L. dussumieri* were also arrived at from the length frequency data by applying integrated method (Pauly, 1982, 1983) and Lα and K were estimated based on Ford-Walford plot. 't_0' was computed by plotting Log e (L_α-Lt) against t. The growth parameters, L_α, K and t_0, so computed for male were 473 mm, 0.6518/annum and -0.1109 and for female, 496 mm, 0.8636/annum and 0.0123 respectively.

The von Bertalanffy's growth equation for *L. dussumieri* can, therefore, be expresed as:

male, Lt = 473 [1-exp-0.6518(t+0.1109)]

and

female, Lt = 496 [1-exp-0.8636 (t-0.0123)]

The total mortality (Z) and natural mortality (M) were computed following different methods and the results are given in Table 1. Among the various estimates of total mortality, the one obtained from length converted catch curve was lowest both in male (Fig. 3) and female (Fig. 4). The fishing mortality (F) was estimated as 0.5710 in male and 1.2485 in female. Therefore, the exploitation rates were E = F/Z = 0.3991 and 0.5347 respectively in males and females. The estimated values for F were slightly lower than estimates of average F (0.2343 and 0.2931 in case of males and females respectively) obtained from the cohort analysis.

Table 1. Instantaneous rates of mortality in *Labeo dussumieri* of the river Pampa

Methods	Male			Female		
	Z	M	F	Z	M	F
Beverton and Holt method	1.4680			1.7693		
Pauly's pile up method	1.3535			2.5450		
Length converted catch curve method	1.4700			2.6900		
Rikhter and Effanov method		1.0131			1.3507	
Sekharan's method		0.9824			1.2434	
Pauly's Empirical relationship method		0.5831			0.6848	
Average	1.4305	0.8595	0.5710	2.3348	1.0930	1.2418

The results of the length converted cohort analysis are shown in Figs. 5 and 6. Both in males and females, specimens below 90 mm were found not vulnerable to exploitation. While examining the stress exerted by fishing mortality to the

stock, it could be seen that there was a gradual increase of rate of mortality up to 370 mm size in males and 390 mm size in females.

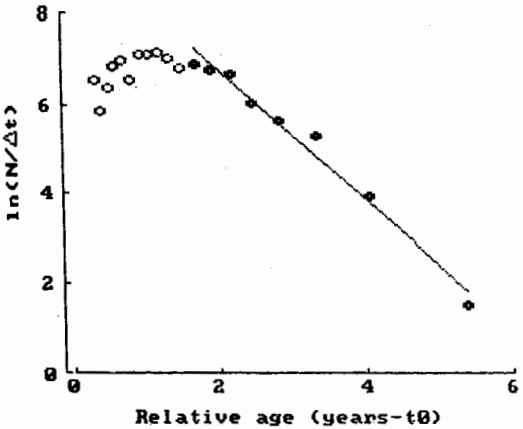

Fig. 3. Catch curve of *Labeo dussumieri* (Male) based on length composition (Lα = 464.7 mm, K = 0.64/year)

In the present study, L_α of *L. dussumieri* was estimated by employing ELEFAN I, as 474 mm for male and 493 mm for female. These, in comparison with other *Labeo* spp. of Indian waters (Rao & Rao, 1972; Rao, 1974; Khan & Jhingran, 1975), were very low and it may be due to the short life span of this species. L_α and K estimated by integrated method of Pauly (1983) and ELEFAN I were also almost comparable and L_α values so computed were distinctly above the L max of both the male and female, as fish longer than 454 mm and 458 mm respectively have not been recorded. The possible existence of one brood to the commercial fishery is reflected in the growth curves obtained from ELEFAN I and these findings agree with the observation of Kurup (1994) that *L. dussumieri* is characterized with a short and precise spawning season. The b values in the length-weight relationships of male and female were slightly above the isometric value of 3 indicating that the weight increase was a power of more than 3 with unit increase in body length, as reported for Indian major carps. (Mohan & Sankaran, 1988). However, this finding is at variance with that of Rao (1974) and Rao & Rao (1972).

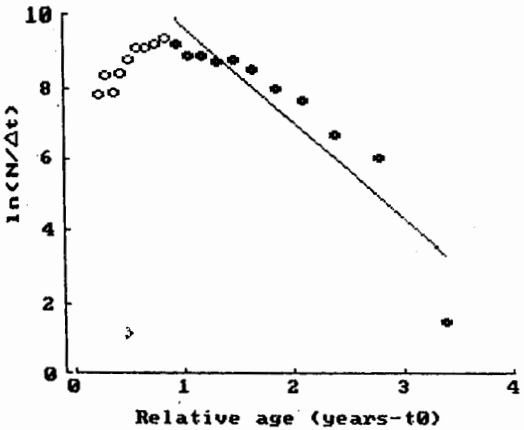

Fig. 4. Catch composition of *Labeo dussumieri* (Female) based on length composition (Lα = 502 mm, K = 0.81/year)

The natural mortality coefficient M was estimated following three different methods. The values were comparable in both the sexes and the average value was used for stock assessment studies. In the present study, estimation of M

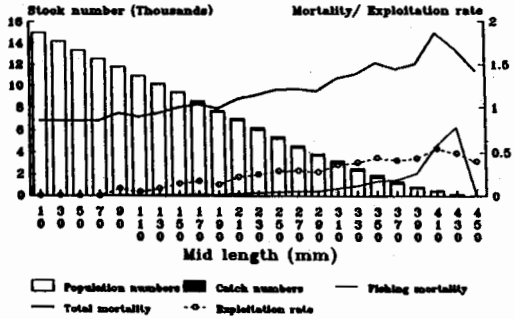

Fig. 5. Length cohort analysis of *Labeo dussumieri* (male) in Pampa river
(Lα = 464.7 mm, K = 0.64/year, M = 0.8595/year, Z = 1.4305, Terminal F = 0.7802
Mean F>230 mm = 0.2343, Terminal exploitation ratio = 0.3991

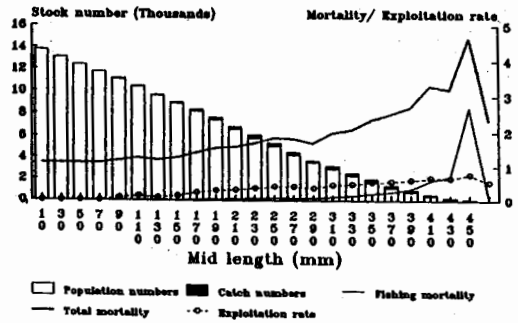

Fig. 6. Length cohort analysis of *Labeo dussumieri* (female) in Pampa river
($L\alpha$ = 502 mm, K = 0.81/year, M = 1.0862/year
Z = 2.3347/year, Terminal F = 2.6833
Mean F>230 mm = 0.2931, Terminal exploitation ratio = 0.5347

based on regression of Z against effort was not attempted due to problems associated with the computation of effective effort of gear involved in the fishing of *L. dussumieri* in river Pampa. M/K ratio is generally used as an index for checking the validity of M and K values estimated by different methods and it is known to range from 1 to 2.5 (Beverton & Holt, 1959). The estimated K values obtained for male and female of *L. dussumieri* were 0.64 and 0.81 respectively and the M values estimated for male were 1.0131, 0.9824 and 0.5831 while that for female were 1.3507, 1.2437 and 0.6648. Thus M/K ratios in male were worked out to be 1.58, 1.53 and 0.91 whereas in female they were 1.67, 1.53 and 0.82. M/K ratio obtained by the methods of Rikhter & Effanov (1976) and Sekharan (1975) were with in the known limits. The values obtained by the method of Pauly (1980) was slightly lower in the case of both male and female. It may therefore, be inferred that estimate of M following the former two methods appeared to be reasonable in comparison with the M obtained from the latter.

The results of the present study show that the male population of *L. dussumieri* in the river Pampa is harvested below optimum level (E = 0.40) while the female population is exploited at the optimum level (E = 0.53). Though there are every possibility to enhance the production of the male population by intensifying the fishing efforts, this increase in effort would result in the over exploitation of the female population as they are coexisting in the same fishing ground. It may therefore be concluded that the sustainable harvest of this endangered species in the river Pampa would be possible by maintaining the present level of exploitation rate.

Acknowledge

This work was done as part of the ICAR ad-hoc research project 4(3)/86-ASR(1) and the financial assistance from the Council is gratefully acknowledged. The valuable suggestions given by Dr. Srinath, CMFRI is acknowledged. Thanks are also due to Sri. Harikrishnan and Suresh Kumar for the assistance rendered in the data processing using FiSAT package.

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