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SCALE STRUCTURE, AGE AND GROWTH IN THE FRESHWATER CARP, *LABEO CALBASU* (PISCES/CYPRINIDAE) FROM HARIKE WETLAND, INDIA

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ABSTRACT

Age structure and growth profile based on the scale studies of 468 specimens ranging from 17-62 cm total length of *Labeo calbasu* (Hamilton) from Harike wetland (30^{0}13'N, 75^0 12'E), Punjab, India have been described. the present study showed better growth in terms of two important growth parameters namely index of species average size and population weight-growth intensity. Two distinct phases in its life history have been described that indicates the optimum exploitation of this species from this waterbody. Harvestable size is found to be fish of 34 cm total length. The detailed structural elaboration of scale (normal, regenerated, lateral line) has also been done using scanning electron microscopy (SEM).

Keywords: Scale, SEM, Age, Growth, Stock Management.

INTRODUCTION

Labeo calbasu (Hamilton) is a widely distributed major carp inhabiting most of the southern regions of Asia including India, Pakistan, Bangladesh, Myanmar, Nepal, Thailand and South-Western China. This species occurs in rivers and ponds and feeds on plants, filamentous algae and diatoms (Talwar and Jhingran, 1991). The maximum reported size for this fish is 90cm (Day, 1878) but during the last few decades this size has not been reported. Further a declining trend in the yield of *L. calbasu* and other Indian major carps has been envisaged due to extensive use of pesticides and weedicides in the catchment areas and introduction of exotic carps in their natural habitats (Tandon and Johal, 1982).

Being an important commercial fish, this species has been studied by several workers. Alikunhi (1957) and Pathak (1975) studied different aspects of its biology. Rao and Rao (1972), Gupta and Jhingran (1973), Johal and Kingra (1988), Tandon *et al.* (1989), Johal *et al.* (1993, 1996, 2001) studied the age and growth aspects of this fish using scales. The present study is a contribution to the age and growth of this species from Harike wetland. This wetland is of great significance due to its international importance as a Ramsar site. It is an investigation for studying the existing ecological status of this fish in terms of various growth parameters and will provide a baseline for effective management of this waterbody to sustain its fishery potential.

To add further, scales are always considered an important research material for fish biologists. Numerous structural features are engraved on its surface that are found to be very important in fish taxonomy and classification (DeLamater *et. al.,* 1972; Delamater and Gourtenay, 1973 a,b, 1974; Chervinski and Shapiro, 1988). The literature is strongly endowed with references to the structural analysis of scales using the magnifying potencies of SEM for this purpose (DeLamater and Courtenay, 1972; Lanzing and Higginbotham, 1974; Hughes, 1981; Hollander, 1986; DiCenzo and Sellers, 1998; Johal and Thomas, 2000). In the present study, along with the use of scales for age and growth study, the detailed structural analysis of scale was done to contribute scale data to this fish species using Scanning Electron Microscopy (SEM). All the three types of scales *viz.,* normal, regenerated and lateral line were analyzed for this purpose.

MATERIAL AND METHODS

Scales from 468 specimens ranging from 17 - 62 cm total body length collected during February 2001 - March 2003 from Harike wetland, Punjab, India ($31^0$13'N, 75^0 12'E) were studied. The methods of scale collection, preparation for study and age determination including the growth parameters were based on standard methodology (Tandon and Johal, 1996).

For SEM analysis, normal scales were removed from 2nd / 3rd row of scales above the lateral line exactly below the dorsal fin. Lateral line scales were selected from the middle of the line while regenerated scales were taken from appropriate regions of the body. All type of scales were washed and sonicated to remove extraneous matter. Thoroughly cleaned and air dried scales were coated with 100 A^0 thick gold-palladium alloy and observed under JEOL-JSM 6100 Scanning Electron Microscope.

RESULTS AND DISCUSSION

Scale structure : Analysis of scale structure using SEM revealed numerous hidden architectural details. The normal scale is longer than broad with its centre having well marked focus. It is the first part of the scale to be formed and constitutes a common axis around which the elevated ridges, circuli are laid in a regular manner. This region of scale possesses a distinct larval mark characterized by discontinuous, closely spaced circuli and the periphery of this ring gives space to the radii (Fig. 1a). All the three types of radii *viz.* primary, secondary and tertiary are present. Irrespective of the difference in their lengths all are deep grooves that are meant for increasing the surface area of scale to accommodate growth ridges (Fig. 1b). Circuli on the scale constitute the elevated ridges with upper smooth circular margins. Equally spaced small elevated projections, the lepidonts are present on these circuli and are meant for anchoring the scale to the body of fish (Fig. 1c). The zones where the circuli are closely packed are the annuli that form the basis for age and growth study. The annulus, in SEM elaboration, shows the presence of irregular, few broken circuli that extend throughout the periphery of scale (Fig. 1d).

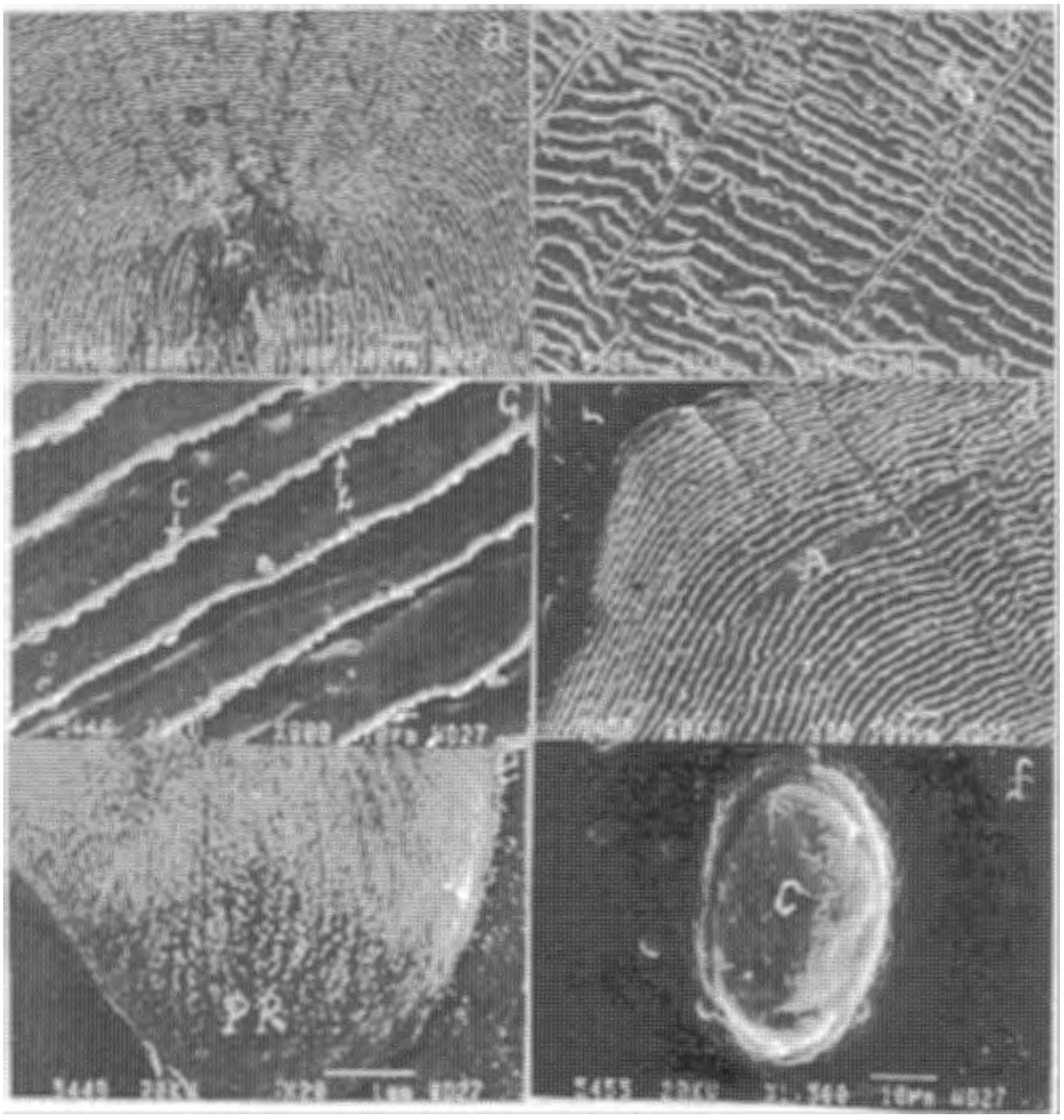

Fig.1 : SEM micrographs of normal scale of L. calbasu *showing*
1a : Focus (F) and Larval Mark (LM)
1b : Radii (R)
1c : Circuli (C) and Lepidonts (L)
1d : Annulus (A)
1e : Chromatophores in posterior region (PR)
1f : Single chromatophore (C) in magnification

The posterior exposed region of scale is covered with skin that folds variously to form chromatophore bearing tubercles. These tubercles give color to fish body and are elongated, biconvex discs of various sizes and shapes (Fig. 1e).

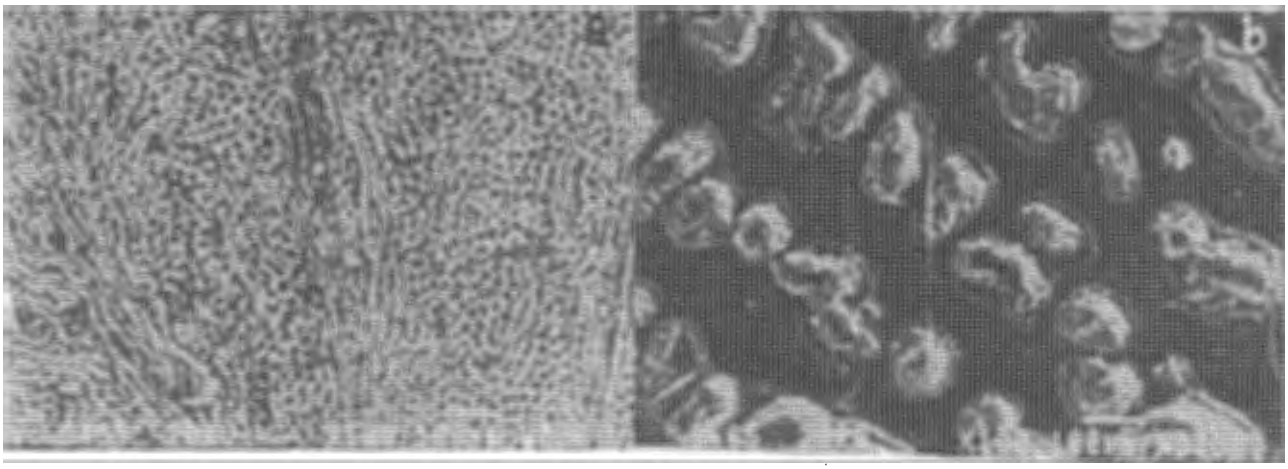

Fig. 2 : SEM micrographs of regenerated scale of L. calbasu *showing*
2a : Regenerated region
2b : Chromatophores of regenerated scale

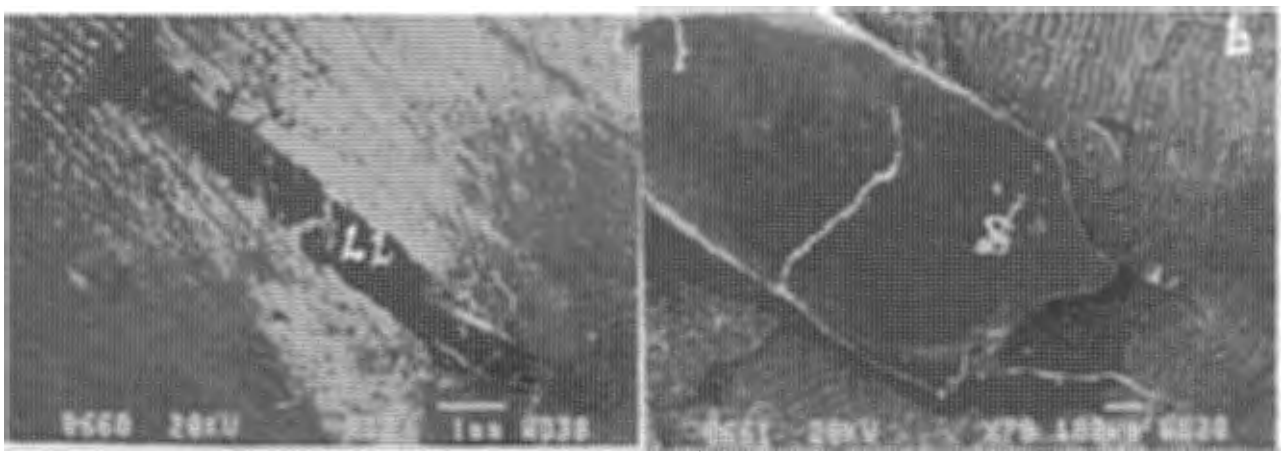

Fig. 3 : SEM micrographs of lateral line scale of L. calbasu showing
3a : Lateral line canal (LL)
3b : Anterior ending of sheath (S) covering lateral line

The regenerated or replacement scale that is formed as a result of injury to body shows different structural architecture when compared with normal scale. The regenerated platelet is marked by the presence of a meshwork of irregularly arranged small bony flakes (Fig. 2a). Regularity is attained after the scale resumes its original size. This scale is devoid of focus possesses sparse and irregularly arranged radii and its chromatophores differ considerably from those of the normal scale (Fig. 2b).

The lateral line when viewed through SEM appears to be uniformly covered with a cover having perforations on its surface. The periphery of the lateral line has irregularly arranged circuli with no uniformity (Fig. 3a, b). The lateral line is characteristic with respect to its shape, position, perforations and anterior margin of covering sheath.

Age and growth study: The cycloid scales of *L. calbasu* exhibit circuli, the distance between which decreases during winter and increases during summer indicating slow and fast periods of growth respectively. The spawning act of this species during the south-west monsoon causes the annulus formation with circuli showing irregular arrangement during July-August. In addition to the presence of true annuli on scale, there are false annuli and larval mark; but for the growth study only the true annuli corresponding to clear cut grooves extending to all sides of scale were considered. As far as the shape of scale and the characteristics of various types of annuli are concerned the facts conform to the earlier observations made on scale of *Labeo* species (Gupta and Jhingran, 1973; Singh, 1978; Tandon and Johal, 1983; Tandon *et al.,* 1989; Johal *et al.,* 1993, 1996, 2001).

A linear relationship between total fish length and lateral scale radius (Fig. 4) with high degree of positive correlation (r = 0.92) was observed. The regression equation has been calculated by the method of least squares and is as under.

$$Y = -2.02 + 0.43\ X \quad (r=0.92\ ;\ N=468)$$

Where Y stands for lateral scale radius in cm and X for total length in cm and N is the total number of specimens. The regression line so calculated fitted the data well and when extrapolated, cut the X axis at 3 cm or 30 mm that corresponded to a length at which the scales first made their appearance on fish body. This is regarded as correction factor.

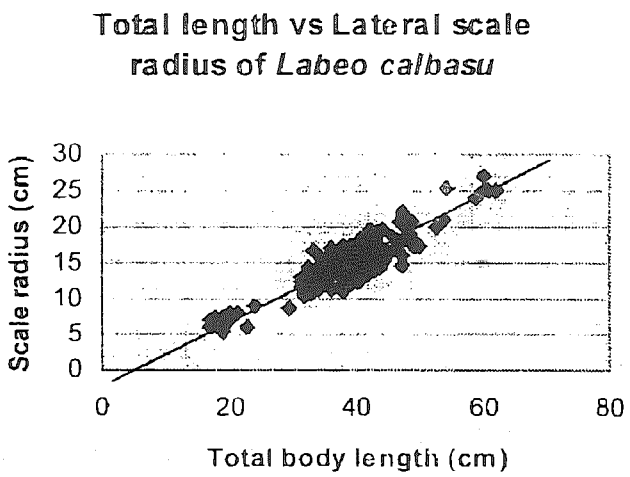

Fig. 4 : Relationship between total length and lateral scale radius in L. calbasu from Harike. Total body length (cm) along abscissa and lateral scale radius (cm) along ordinate.

Based on the scale observations, back lengths and growth increment for each age class were calculated (Table 1). Present sample showed six age classes in the population. Maximum number of specimens belonged to age class III followed by IV, II, V, I and VI respectively. This indicated maximum vulnerability of age class III and IV to fishing gears. So far maximum number of age classes was reported from river Yamuna and Jaisamand Lake (I-VIII) and minimum from River Ghagger (I-V) for this species (Gupta and Jhingran, 1973; Tandon *et al.,* 1989).

Maximum growth as shown by annual growth increment (h) occurred in the first year of life with a declining trend as age increased except in age class VI indicating the phenomenon of growth compensation at this age. This phenomenon has been given profound importance by several workers in the life history of a fish species (Hile, 1936; Van Oosten, 1939, 1942; Deason and Hile, 1947; Valtonen and

Table 1 : Back calculated lengths, BCL (cm) for *Labeo calbasu* from Harike wetland during Feb. 2001- March 2003.

AGE	NO.	L(cm)	LSR(cm)	BCL1	BCL2	BCL3	BCL4	BCL5	BCL6
1	31	23.4	7.9	17.70					
2	86	33.8	12.0	18.60	28.66				
3	153	37.5	13.6	17.20	25.57	33.44			
4	106	41.2	15.5	16.55	24.19	31.58	37.01		
5	67	47.0	19.4	16.83	23.63	30.67	36.79	42.01	
6	25	57.6	25.8	14.42	23.52	31.99	41.51	47.01	54.42
Av.	468	40.03	15.78	16.88	25.11	31.92	38.43	44.51	54.42

Valtonen, 1978; Tandon and Johal, 1983, 1996). Its occurance is found to be universal in all natural populations and it can occur at any stage of life. The number of age classes, occurrence of growth compensation conform to the earlier observations made on this species from the same waterbody (Johal *et al.*, 1996, 2001).

Table 2 enlists various growth parameters translating the growth history of this fish species in statistical terms. The specific rate of linear growth (CI) and specific rate of weight increase (Cw) showed a declining trend with sudden rise at the last age class thus strengthening the occurrence of growth compensation in this year class. The index of species average

Table 2 : Growth profile of *Labeo calbasu* from Feb., 2001 - March, 2003

Age Class/Parameters	1	2	3	4	5	6
Back calculated length (BCL in cm)	16.88	25.11	31.92	38.43	44.51	54.42
Annual growth increment (h)	16.88	8.23	6.81	6.51	6.08	9.91
Index of species average size (ϕh)			9.07			
Specific rate of linear growth (Cl)	48.75	27.12	20.39	15.82	22.26	
Growth constant (Clt)	6.70	6.02	5.92	5.64	8.94	
Growth characteristics (Cth)	0.59	0.35	0.27	0.22	0.30	
Weight (W in gm)	133.86	542.06	711.16	921.81	1176.2	2276.1
Annual weight increment (w)	133.86	408.20	169.10	210.65	254.39	1099.9
Specific rate of weight increase (Cw)	304.95	31.19	29.62	27.59	93.51	
Index of population weight growth intensity (ϕCw)			97.37			

size (ϕh) was found to be 9.07 which when compared from other localities supported the fact that this fish species is essentially a riverine species that enjoys luxuriant growth in open water that provides more space and food but less competition (Tandon *et al.,* 1989; Johal *et al.,* 1993, 1996, 2001). It also indicates that this species is better adjusted to existing conditions of its habitat.

The values of growth constant (Clt) and growth characteristics (Cth) are important for predicting various periods in the life of a fish. From the growth data, it is apparent that *L. calbasu* shows two distinct phases in its life history. An earlier phase of reproductive immaturity that lasts for only one year and a continuous reproductive phase that lasts till the last age class. Absence of old age as indicated from the growth constant and growth characteristics shows optimum exploitation from this water body. Earlier investigations support the existence of two phases except the population inhabiting Jaisamand Lake where the species attains old age (Rao and Rao, 1972; Gupta and Jhingran, 1973; Johal and Kingra, 1988; Tandon *et al.,* 1989; Johal *et al.,* 1993, 1996, 2001).

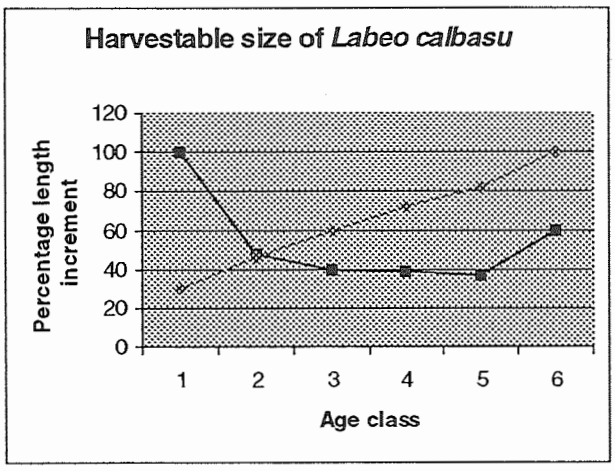

Fig.5 : Graph showing minimum theoretical harvestable size in L.calbasu *from Harike. Dark line is for total length in percentage of the length of last growth season and light line for length increment in percentage of first growth season.*

The point of intersection of length increments as percentage of the length of final growth season gives minimum theoretical harvestable size. In *L. calbasu,* the point of intersection lies at the end of second year (Fig. 5). It means that the fish should be harvested after the completion of second year when it has attained a size of 34 cm total fish length. This size is reported to be 34 cm from river Ghaggar at Rangmahal (Tandon *et al.,* 1989), 35 cm from Jaisamand Lake, Rajasthan (Singh, 1990), 26 cm from Harike (Johal *et al.,* 1996; 2001). Since the harvestable size depends upon the growth rate of fishes, there could be different harvestable sizes of the same fish species from different localities. The ultimate size attained by *L. calbasu* was calculated to be 72 cm (Fig. 6). While the maximum size in the collected sample was 62 cm which showed that this water body can further be exploited for even the bigger samples.

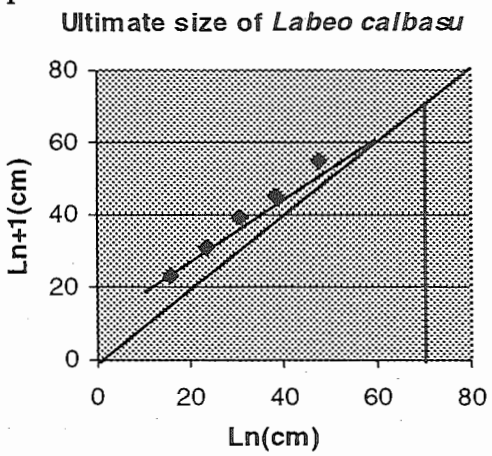

Fig.6 : Graph showing ultimate size of L.calbasu from Harike

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