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GROWTH OF INDIAN MAJOR CARPS AND A CHINESE CARP IN EXTENSIVE CULTURE SYSTEM IN RAIPUR RESERVOIR, GWALIOR, M.P., INDIA

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Abstract- The length-weight relationship of carps was studied in Raipur reservoir, Gwalior from April, 2009 to March, 2011. Four major carps species, *viz., Catla catla, Labeo rohita, Cirrhinus mrigala* and *Cyprinus carpio* were cultivated in the reservoir. The growth of carps was studied from April, 2009 to March, 2010 during first year, while in second year growth studies were conducted during August, 2010 to March, 2011. In the year 2010-11, however, the reservoir dried up during the period from April, 2010 to July, 2010 due to low rains during the rainy season and high evaporation during the summer. The values of 'n' for *C. catla, L. rohita, C. mrigala* and *C. carpio* were 2.438, 3.399, 2.844 and 2.358 respectively in this water body during 2009-10, while the values of 'n' for *C. catla, L. rohita, C. mrigala* and *C. carpio* are 2.856, 2.827, 2.771 and 2.394 respectively were during 2010-11. The value of coefficient of correlation (r) between length and weight shared a perfect positive relationship in all the fishes studied during both the years of study. A total of 200 specimens of each of four species were taken and a logarithmic graph plotted between length and weight has shown a straight line in all the four carps. The condition factor 'K' for *C. catla* revealed that with the progression of growth of the fish, the well being of fish decreased as this factor is showing a decreasing pattern while in *L. rohita* fish attains good growth and size in comparison to other fishes and a positive pattern of condition of fish was observed. The condition factor 'K' for *C. mrigala* revealed that with the progression of growth of the fish, the well being of fish increased with increased age and in C. *carpio* a decreasing pattern with the progression of growth in the fish was shown, thus the well being of fish was also low. The absolute growth may be concluded that the growth increment during first year of culture the growth was highest in *L. rohita* in comparision to other carps while in second year maximum growth was exhibited by *C. catla* and minimum growth by *C. carpio.* It was found that rohu had good absolute growth in the reservoir in the first year. However, in second year of study, it was catla who had a little edge over rohu. *C. carpio* grew the least in comparison to other carps. On the basis of physico-chemical characteristics of the Raipur reservoir, it may be classified as meso-eutrophic one.

Keywords- Length-weight relationship, Condition factor, Absolute growth, Relative growth, Culturable carps

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Introduction

The length-weight relationship forms an important criterion for studying the growth of fish populations [1]. The exponential value must be exactly 3, but in reality, the actual relationship between length and weight may depart from the ideal value due to environmental conditions or condition of fish [2]. The condition factor (K) of fish on the other hand presents valuable information regarding maturity spawning, availability of food, its degree of fatness and environmental conditions. The evaluation of the general condition and well being of the fish is also determined through the study of condition factor (K) while, the absolute growth is the daily increment in weight of fish. This relationship serves three purposes *viz*. i) to determine the type of the mathematical relationship between two variables so if one variable is known, the other could be computed; ii) the relative condition can be estimated to assess the general well being of the fish and type of growth, *i.e.,* whether isometric or allometric and iii) it helps to estimate the potential yield per recruit in the study of fish population dynamics. In fishes, generally the growth pattern follows the cube law. Such relationship for the fishes will be valid when the fish grows isometrically Brody [3,4]. Both the length-weight relationship and condition factor are important tools. The present paper aims to study the length-weight relationship, condition factor and absolute growth of stocked Indian major carps and a Chinese carp in Raipur reservoir, Gwalior.

Materials and Methods

Raipur reservoir was constructed on Swarnrekha river in 1877 by the then Maharaja Shrimant Jiyaji Rao Scindia of Gwalior. The reservoir is situated near Nayagaon village in Gwalior district, Madhya Pradesh. The water of this reservoir is used for irrigating crop fields and for culture fisheries. Geographically, the Raipur reservoir lies on 78º03'44.74" E longitudes and 26º08'07.63" N latitude [Fig-1].

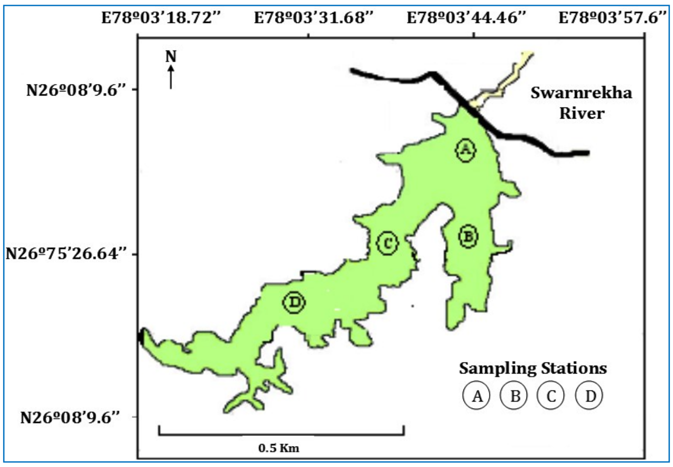

Fig. 1- Showing various sampling stations in Raipur reservoir

The reservoir dried from April, 2010 to July, 2010 due to low rains during the rainy season and high summer heat. The average depth of reservoir was 4.5 m. The physico-chemical characteristics were estimated following the standard methods of APHA *et al*. [5]. The total number of fingerlings stocked in reservoir was in rohu-50,000, catla-2 00,000, mrigal- 50,000 and common carp- 100,000. In order to study the fish growth in this reservoir, the carps, *viz*., *Labeo rohita, Catla catla, Cirrhinus mrigala* and *Cyprinus carpio* were stocked. The length and weight of 10 specimens each of all the fish were measured on monthly basis. The length-weight relationship, condition factor and absolute growth of fishes were estimated. They were calculated by following formulae:

Length-Weight Relationship

The length-weight relationship was estimated by least square method as suggested by Le-Cren [2]. It is expressed as under:

$$W = aL^{n} \quad \text{Or} \quad \text{Log}\, W = \text{Log}\, a + n\, \text{Log}\, L$$

Where,
W = Weight of fish in g
L = Length of fish in mm
a and n are the constants

Condition Factor

The condition factor 'K', which is based on the cube law, was calculated in order to compare the condition of fishes under various culture regimes in numerical terms by using following formula of Hile [6]:

$$W = K L^{3} \qquad K = \frac{W}{L^{3}} \times 100$$

Where,
K = Condition factor
W = weight of fish in g
L = Length of fish in cm
100 is a constant

Coefficient of Correlation

The coefficient of correlation (*r*) for fish growth was calculated by using following formula given as under:

$$\text{Correlation of coefficient (r)} = \frac{\sum dx\, dy - \frac{\sum dx \times \sum dy}{n}}{\sqrt{\left\{\sum dx^{2} - \frac{\sum dx^{2}}{n}\right\}\left\{\sum dy^{2} - \frac{\sum dy^{2}}{n}\right\}}}$$

Where,
S*dx* = Sum of the deviation of x variable from the mean
S*dy* = Sum of the deviation of y variable from the mean
dx^2 = Square deviation from the mean of x variable
dy^2 = Square deviation from the mean of y variable
n = Total number of scores

Absolute Growth

The absolute growth of carps was calculated by the following formula:

$$\text{Absolute Growth} = \frac{W_1 - W_0}{T_1 - T_0}$$

Where,
W_0 = Initial weight of fish in g
W_1 = Final weight of fish in g
T_0 = Initial time of fish in g
T_1 = Final time of fish in g

Results

The range of variations and mean values along with standard error of physico-chemical characteristics of water during 2009-11 are given in [Table-1]. Considering the various physico-chemical characteristics and their comparison with the values of different authors, the reservoir is classified as meso-eutrophic [Table-2].

Table 1- Range of Variations and Mean with Standard Error of Physico-Chemical Characteristics of Water of Raipur Reservoir at Sub-Surface during April, 2009 to March, 2011

S.N.	Parameters	Unit	2009-2011		
			Minimum	Maximum	Mean ±SE
1	Ambient temperature	^0C	20.4	41.1	32.6±1.48
2	Water temperature	^0C	14.8	31.3	25.3±1.14
3	Depth	M	1.12	4.42	2.89±0.217
4	Transparency	Cm	29.5	111.5	76.5±4.29
5	Colour		L.G	Green	Green
6	Electrical conductivity	μScm^{-1}	288.4	421.5	344.0±8.89
7	Turbidity	NTU	3.85	15.23	9.84±0.77
8	Total solids	mgL^{-1}	263.9	385	315.39±8.25
9	Total dissolved solids	mgL^{-1}	179.6	273.6	216.9±6.04
10	Total suspended solids	mgL^{-1}	84.3	114	98.5±2.28
11	pH		7.93	9.05	8.43±0.06
12	Dissolved oxygen	mgL^{-1}	7.49	9.63	8.65±0.15
13	Free carbon dioxide	mgL^{-1}	NIL	9.3	3.92±0.71
14	Total alkalinity	mgL^{-1}	49.3	105.5	75.07±3.36
15	Total hardness	mgL^{-1}	102	167.7	136.7±4.39
16	Chlorides	mgL^{-1}	24.1	85.2	40.6±1.60
17	Sulphates	mgL^{-1}	3.7	12.6	7.60±0.54
18	Nitrate-nitrogen	mgL^{-1}	0.25	0.87	0.623±0.035
19	Nitrite-nitrogen	mgL^{-1}	0.033	0.089	0.058±0.003
20	Inorganic phosphorous	mgL^{-1}	0.029	0.086	0.054±0.003
21	Silicates	mgL^{-1}	2.7	12.7	7.62±0.69
22	Ammonia	mgL^{-1}	0.42	1.56	0.93±0.06
23	Sulphides	mgL^{-1}	0.69	1.44	0.96±0.05
24	BOD	mgL^{-1}	2.65	6.94	4.7±0.27
25	COD	mgL^{-1}	58.7	120.5	87.4±3.68
26	Calcium	mgL^{-1}	26.8	44.6	36.7±0.93
27	Magnesium	mgL^{-1}	8.46	18.8	14.5±0.64
28	Sodium	mgL^{-1}	8.55	16.4	12.2±0.44
29	Potassium	mgL^{-1}	4.25	7.53	5.93±0.23

In the present study, it was observed from Raipur reservoir that, the length weight relationship of *C. catla* (n= 2.618), *L. rohita* (n= 2.794), *C. mrigala* (n= 2.10) and *Cyprinus carpio* (n= 2.552) have been carried out during first year, *i.e.,* 2009-10 of study. In the second year of study, *C. catla* (n= 2.856), *L. rohita* (n= 2.827), *C. mrigala* (n= 2.771) and *C. carpio* (n= 2.394). The value of 'n' is greater than 3 showed the fish grows isometrically (n=3.399) and in case of other fishes all the fishes has value of 'n' to be closer than '3', indicates growth was satisfactory. The value of coefficient of correlation was found to be in perfect positive relationship among all the fishes studied. The average length and weight of different carps in Raipur reservoir, Gwalior during 2009-10 and 2010-11 has shown in [Table-3]. The linear regression equation, exponential equation and coefficient of correlation for various carps in a extensive culture system in Raipur reservoir has shown in [Table-4].

The values of condition factor 'K' for different fishes have been shown in [Table-5]. The condition factor 'K' for *C. catla* revealed that with the progression of growth of the fish, the well being of fish decreased as this factor is showing a decreasing pattern from length group of 21.0 to 21.9 cm onwards while, in rohu, it was found that the values of 'K' in *L. rohita* showed that the fish attained good growth in comparison to other fishes.

The condition factor has shown an increasing pattern of condition of fish. The condition factor 'K' values for *C. mrigala* revealed that with the progression of growth of the fish, the well being of fish increased as this factor has shown an increasing pattern. On the contrary in common carp the values of 'K' were showing a decreasing pattern with the progression of growth in the fish, thus decreasing the well being of fish.

In the present study, in Raipur reservoir the absolute growth may be concluded that the growth increment during first year was highest in *L. rohita* in comparison to other carps, while in second year of study, the growth was highest in *C. catla* and lowest in *C. carpio.* It was found that rohu had good growth in the reservoir in the first year, and in second year of study, it was catla who had a little edge over rohu. The value of absolute growth in different fishes was calculated at monthly intervals and has been given in [Table-6].

Table 2- Trophic Status of Raipur Reservoir

S.N.	Parameters	Unit	Mean±SE	Trophic status of reservoir	Ref.
1.	Calcium	mgL^{-1}	36.72±0.93	Rich Calcium (>26.0 mg L^{-1})	[45]
2.	Electrical Conductivity	μScm^{-1}	344.04±8.89	Mesotrophic (300.0 to 500 µS/ cm)	[46]
3.	Total alkalinity	mgL^{-1}	75.07±3.36	Nutrients rich (60.0 mg L^{-1} <)	[47], [48]
4.	Total hardness	mgL^{-1}	136.77±4.39	Moderately hard (76.0 to 150.0 mg L^{-1})	[49]
5.	Nitrate-nitrogen	mgL^{-1}	0.62±0.03	Eutrophic (0.15-0.75 mg L^{-1})	[50]
6.	Free carbon dioxide	mgL^{-1}	3.92±0.71	Soft (nil-4.3 mg L^{-1})	[51]
7.	Phosphates	mgL^{-1}	0.054±0.003	Eutrophic (>0.04 mg L^{-1})	[52]
8.	Transparency	cm	76.59±4.29	Eutrophic (>170.0 cm)	[52]
9.	Chlorides	mgL^{-1}	40.67±1.60	Less domestic Pollution (17.9-57.6 mg L^{-1})	[53]
10.	pH	-	8.43±0.060	Alkaliphilous (7.5 to 9.0)	[54]
Trophic Status of Raipur Reservoir Meso-Eutrophic					

Table 3- Average length and weight of different carps in Raipur reservoir, Gwalior during 2009-10 and 2010-11

Months	*Catla catla*				*Labeo rohita*				*Cirrhinus mrigala*				*Cyprinus carpio*			
	2009-10		2010-11		2009-10		2010-11		2009-10		2010-11		2009-10		2010-11	
	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)	L (cm)	W (gm)
April	24.25	252	-	-	24.35	168.5	-	-	24.39	155.6	-	-	20.91	126.2	-	-
May	30.1	361.5	-	-	29.86	302.5	-	-	26.32	193.2	-	-	24.63	177	-	-
June	32.87	514	-	-	32.92	412.2	-	-	29.92	286.7	-	-	25.87	273.3	-	-
July	33.29	555	-	-	33.83	453.2	-	-	34.57	423.5	-	-	29.78	321.3	-	-
August	34.9	630	13.4	35	34.66	534.5	12.3	24.3	36.86	456	11.3	21	33.28	374.6	9.98	33.3
September	37.45	727.5	20.8	85	35.53	665.5	15.4	47.3	38.81	491.5	13.51	30.5	34.84	397.9	18.27	87.5
October	36.95	739.5	26.8	172.9	35.46	672	25.1	151.6	38.73	502.3	22.9	127	37.35	526	24	109.7
November	36.99	745.5	26.8	299.3	35.7	678.5	26.6	234.9	37.6	507	27.1	216	36.96	550.4	23.7	143.8
December	37.64	758	29.6	350	36.06	728	27.9	273	37.11	521	31.1	308.5	37.31	583.3	21.3	176.2
January	37.74	772.3	31.7	462	37.11	772	30.7	324.7	37.85	544.9	31.3	322	38.3	588.6	24.7	234.5
February	37.87	808	32.2	495	38.72	842	33.3	414.3	38.97	575.5	30.2	333.2	39.28	603.8	32.9	324.4
March	38.16	836.5	34.2	566	40	923	34.4	514.5	38.48	612.4	31.9	352	40.51	625.8	36.4	419

Table 4- The linear regression equation, exponential equation and coefficient of correlation for various carps in a extensive culture system, Raipur reservoir Madhya Pradesh

S. No.	Species	Linear Regression Equation		Exponential Equation		Coefficient of correlation	
		2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
1	*Catla catla*	LogW=0.108+2.438 Log L	LogW=0.108+2.438 Log L	$W=0.108L^{2.438}$	$W=0.020\ L^{2.856}$	0.98	0.93
2	*Labeo rohita*	LogW=0.108+2.438 Log L	LogW=0.108+2.438 Log L	$W=0.00312\ L^{3.399}$	$W=0.0216\ L^{2.827}$	0.94	0.95
3	*Cirrhinus mrigala*	LogW=0.108+2.438 Log L	LogW=0.108+2.438 Log L	$W=0.0176\ L^{2.844}$	$W=0.0232\ L^{2.771}$	0.98	0.97
4	*Cyprinus carpio*	LogW=0.108+2.438 Log L	LogW=0.108+2.438 Log L	$W=0.1034\ L^{2.358}$	$W=0.047\ L^{2.394}$	0.97	0.93

Table 5- Showing data of condition factor 'K' of four fish species from Raipur reservoir, Gwalior during 2009-10 and 2010-11

S.No.	Groups	No. of Specimen	A.L (cm)	A.W (gm)	L^3	W/L^3	$K = \frac{W}{L} X100$	Groups	No. of Specimen	A.L (cm)	A.W (gm)	L^3	W/L^3	$K = \frac{W}{L} X100$
							Catla catla							
1	210-219	2	21.5	212.5	9938.38	0.0213818	2.14	100-126	5	11.2	28	1404.9	0.0199298	1.99
2	229-248	4	23.9	243.8	13617.68	0.0179032	1.79	126-152	1	13	30	2197	0.0136549	1.37
3	248-267	3	25.5	273.3	16581.38	0.0164823	1.65	152-178	6	16.67	50	4632.4	0.0107935	1.08
4	267-286	4	27.7	315	21323.06	0.0147727	1.48	178-204	3	19.33	75	7222.6	0.010384	1.04
5	286-305	3	29.3	346.7	25231.1	0.013741	1.37	204-230	5	22.36	158.6	11179.3	0.0141869	1.42
6	305-324	10	31.6	495.5	31404.95	0.0157778	1.58	230-256	8	24.38	201.1	14491.1	0.0138774	1.39
7	324-343	13	32.9	512.7	35546.38	0.0144234	1.44	256-282	10	27.64	266.5	21116.1	0.0126209	1.26
8	343-362	19	35.7	661.6	45308.39	0.0146022	1.46	282-308	11	29.5	319	25672.4	0.0124258	1.24
9	362-381	48	37.5	761.3	52861.04	0.0144019	1.44	308-334	22	31.81	460.2	32187.7	0.0142973	1.43
10	381-400	14	39.1	841.4	59547.44	0.0141299	1.41	334-360	9	35.14	583.8	43391.5	0.0134542	1.35
							Labeo rohita							
1	220-242	4	23	130.5	12167	0.0107257	1.07	90-117	4	10	13.7	1000	0.0137	1.37
2	242-264	7	25.4	197.6	16367.7	0.0120725	1.21	117-144	9	13.11	28.7	2253.2	0.0127371	1.27
3	264-286	3	27.3	240	20413.5	0.0117569	1.18	144-171	5	16.26	61	4298.9	0.0141895	1.42
4	286-308	2	30	285	27000	0.0105556	1.06	171-198	1	19	100	6859	0.0145793	1.46
5	308-330	10	32.4	394	34138.4	0.0115413	1.15	198-225	2	21.1	125	9393.9	0.0133064	1.33
6	330-352	33	34.4	516.3	40636.6	0.0127053	1.27	225-252	5	24.22	147	14207.6	0.0103465	1.03
7	352-374	38	36	717.3	46617.1	0.015387	1.54	252-279	18	26.44	226.6	18483.5	0.0122595	1.23
8	374-396	11	38.1	815	55088.8	0.0147943	1.48	279-306	10	29.61	286.8	25960.6	0.0110474	1.1
9	396-418	9	40.5	912.2	66528.5	0.0137114	1.37	306-333	14	32.3	380.5	33698.3	0.0112913	1.13
10	418-440	3	42.9	983.3	78953.5	0.0124542	1.25	333-360	12	34.45	500	40885.4	0.0122293	1.22
							Cirrhinus mrigala							
1	220-240	8	22.9	121.5	12072.03	0.0100645	1.01	90-116	7	10.68	17.1	1218.2	0.0140372	1.4
2	240-260	8	25.4	179.4	16367.72	0.0109606	1.1	116-142	10	12.55	27	1976.7	0.0136594	1.37
3	260-280	3	28	232	21952.0.	0.0105685	1.06	142-168	2	15.5	40	3723.9	0.0107414	1.07
4	280-300	4	29.6	223	25934.34	0.0085986	0.86	168-194	2	17.25	62.5	5133	0.0121762	1.22
5	300-320	11	31.3	372	30546.88	0.012178	1.22	194-220	1	19.5	90	7414.9	0.0121377	1.21
6	320-340	4	32.8	453	35287.55	0.0128373	1.28	220-246	5	23.2	130	12487.2	0.0104106	1.04
7	340-360	12	35.2	440	43651.39	0.0100798	1.01	246-272	11	26.04	195.6	17657.2	0.0110776	1.11
8	360-380	16	37.2	525.3	51520.37	0.0101959	1.02	272-298	15	28.3	265.3	22665.2	0.0117051	1.17
9	380-400	49	39	528	59319	0.008901	0.89	298-324	11	30.68	358.6	28877.9	0.0124177	1.24
10	400-420	5	40.7	631	67419.15	0.0093593	0.94	324-350	16	34.03	355.6	39408.1	0.0090235	0.9
							Cyprinus carpio							
1	170-195	4	18.6	106	6434.8	0.0164728	1.65	70-102	2	8.4	12.5	592.7	0.0210897	2.11
2	195-220	5	21	117.6	9314	0.0126261	1.26	102-134	3	12.06	29	1754	0.0165331	1.65
3	220-245	5	23.6	182.8	13110.9	0.0139426	1.39	134-166	7	14.91	53.8	3314.6	0.0162311	1.62
4	245-270	15	25.8	247.5	17173.5	0.0144117	1.44	166-198	9	17.98	98.3	5812.6	0.0169115	1.69
5	270-295	5	27.7	266	21162	0.0125697	1.26	198-230	17	21.54	139.5	9993.9	0.0139584	1.4
6	295-320	7	31.4	333	30870.5	0.010787	1.08	230-262	18	24.85	168.4	15345.4	0.0109739	1.1
7	320-345	12	33.3	393.6	37025.9	0.0106304	1.06	262-294	3	27.66	276.6	21162	0.0130706	1.31
8	345-370	27	36.1	511.1	46889.7	0.0109001	1.09	294-326	5	31.25	286.2	30517.6	0.0093794	0.94
9	370-395	28	38.6	574.7	57378.5	0.010016	1	326-358	9	34.18	377.6	39931.6	0.0094561	0.95
10	395-420	12	41.2	630.6	69781.9	0.0090367	0.9	358-390	7	37.11	407.8	51106.1	0.0079794	0.8

Table 6- Showing data of absolute growth of carp fishes in Raipur reservoir, Gwalior

Months	*Catla catla* Absolute growth (mg)		*Labeo rohita* Absolute growth (mg)		*Cirrhinus mrigala* Absolute growth (mg)		*Cyprinus carpio* Absolute growth (mg)	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
April	0.0036	-	0.0045	-	0.0013	-	0.0017	-
May	0.0051	-	0.0037	-	0.0031	-	0.0032	-
June	0.0014	-	0.0014	-	0.0045	-	0.0016	-
July	0.0025	-	0.0027	-	0.001	-	0.0017	-
August	0.0033	0.0016	0.0043	0.0007	0.0012	0.0003	0.0007	0.0018
September	0.0003	0.0029	0.0002	0.00006	0.0003	0.0032	0.0042	0.0033
October	0.0002	0.0042	0.0002	0.0027	0.0001	0.0029	0.0008	0.0011
November	0.0004	0.0016	0.0016	0.0012	0.0005	0.003	0.0011	0.0011
December	0.0005	0.0037	0.0015	0.0017	0.0008	0.0004	0.0002	0.0019
January	0.0011	0.0011	0.0023	0.0029	0.001	0.0003	0.0005	0.0019
February	0.0095	0.0023	0.0027	0.0033	0.0012	0.0006	0.0007	0.0012

Discussion

According to Hile [6] and Martin [7], the length-weight relationship of most fishes can be adequately described by the formula $W= aL^n$, where W and L stand for weight and length respectively, 'a' is constant and 'n' an exponent which usually varies from 2.5 to 4.0 in different fish. The 'ideal' fish in terms of length-weight relationship is characterized by a constant shape, and for such a fish n=3; but most species of fish change in shape as they grow so that for the vast majority of instances the cube law fails to hold. Allometric growth means the phenomenon, whereby parts of the same organism grow at different rates. Many other workers have shown that the value of regression coefficient 'n' either lies very close to the cube of length or differs significantly from this. The value of 'n' may change with both the intrinsic as well as extrinsic factors. Agreement or disagreement to the cube law in case of fish is also dependent upon various experimental factors besides body shape, outline and contour as the fish inhabits a variety of habitat. Extrinsic factors such as space, competition for food, enemies and changes in physico-chemical characteristics of water. The intrinsic factors such as age, sex, genetic makeup, reproductive state and endocrine balance etc., influence the growth rate of fish. The health and growth of fish are directly related to the quality of water in which the fish are raised. The general factors affecting fish growth and production in freshwater aquatic systems can be classified as physical, chemical or biochemical or a combination thereof. The physical properties of water, important to fish production and growth include temperature and the concentrations of suspended and settleable solids. Some important chemical parameters include pH, alkalinity, hardness, nutrients, fish food organisms and pollution causing substances.

Jhingran [8] has found the values of 'n' departed slightly from 3*, i.e.,* 3.15, 3.02 and 3.01 in *Cirrhinus mrigala, Catla catla* and *Labeo rohita* respectively, thus means that 'n' values were higher than 3 showed positive allometric growth. Several authors have observed that availability of food and consumption and assimilation of food influence the growth of fish directly [9-11]. The value of 'n' in *C. mrigala* in Ganga at Allahabad was considerably higher than 3 showed positive allometric growth [12]. Chondar [13] has observed the value of 'n' as 3.15 in *L. gonius*, which indicated a positive allometric growth of fish from Keetham reservoir. However, it has been observed that value of 'n' less than 3 for major carp, *Labeo calbasu* and was considered as negative allometric growth in Loni reservoir [14]. Parmeshwaram *et al.* [15] have observed the 'n' values as 3.08 and 3.10 in male and female of *L. gonius* respectively and showing a positive allometric growth pattern. Length-weight relationship of *C. catla* in Ramaua reservoir has been studies and it was concluded that the observed values of growth were very much different from calculated values. The value of 'n' was determined as 2.18 which can be rated as poor growth by any standard [1]. Chatterji [16] have reported 'n' values 3.1 and 3.09 in male and female of *L. gonius* respectively, and thus following the cube law. In Tighra reservoir, it has been concluded that the growth rate of *C. catla* was not exactly similar in all length groups but varied significantly [17]. The fish growth in the reservoir is better as the value of 'n' is greater than 3 thus a positive allometric growth have occured. Kartha and Rao [18] have studied length-weight and length-maximum girth relationship of *C. catla* in commercial landings and the value of 'n' was 2.83 and concluded that the growth was not that good in the case of *C. catla* in Gandhisagar reservoir. In Jaisamand lake, Udaipur, Johal and Kingra [19] reported value of 'n' varying from 2.75 to 3.54 in the Indian major carps. In different aquafarming systems, the value of 'n' varied from 2.012 to 2.79 in catla, 2.2 to 2.33 in rohu and 2.15 to 2.4 in mrigal and the length-weight relationship of Indian major carps exhibited significantly positive correlation between logarithmic values of length and weight of all three species grown [20].

The length-weight relationship of freshwater fish, *Rhinomugil corsula* has concluded that the values of 'n' are very much close to 3.0 and thus this fish follows the cube law [21]. The length-weight relationship of carp exhibited quite unsatisfactory growth as the values of 'n' found to be 2.79 for rohu, 2.61 for catla 2.1 for mrigala and 2.55 for common carp in a fish pond in Gwalior. However, the coefficient of correlation (r) between length and weight showed a perfect positive co-relation in all the fishes [22] while studying length-weight relationship of *L. gonius*, it is indicated that growth was found to be positively allometric and the regression co-efficient in all cases *i.e.,* male, female and male and female taken together showed ideal growth (n=3) in Keenjhar lake, Pakistan [23]. In Nasti baor in Jhinaidah, Hossain *et al.* [24] have studied length-weight relationship of major and exotic carps and the growth of rohu, catla, mrigal and silver carp were isometric and of grass carp and common carp were allometric. The length-weight relationship of *Notopterus notopterus*, showed an isometric growth pattern where value of 'n' were 3.3 for males and 3.56 for females in Bhima river, Pune, Maharastra. The correlation coefficients (r) were registered as 0.98 for males and 0.97 for females which show a good relationship between length-weight parameters [25]. Yosuf *et al.* [26] have studied the length-weight relationship with high correlation coefficient (r) for *Pangasius nasutus* (r=0.96), for *Pseudomystus siamensis* (r= 0.9) and for *Hamibagrus nemurus* (r= 0.83). This has been shown that the length-weight relationship of *Schizopyge esomus* from Kashmir valley, 'n' value in female is maximum because they gain weight at a faster rate in relation to its length and the 'n' values in males indicate negative allometry, which indicates that the increase in length is not in accordance with the increase in weight [27]. Similar observations have been recorded by several fishes like *C. catla* in Ramaua reservoir [1], *C. catla* in Tighra reservoir [17], *Rhinomugil corsula* in Bangladesh [21], *C. catla, L. rohita, C. mrigala* and *C. carpio* in fish farm at Gwalior [22], *L. gonius* in Keenjhar lake [23], *Notopterus notopterus* in Bhima river, Pune [25], *Pangasius nasutus*, *Pseudomystus siamensis* and *Hamibagrus nemurus* in Peninsular Malasiya [26] and in *Schizopyge esomus* in Jhelum river in Kashmir [27].

The condition factor 'K' plays an important role in fisheries research and is helpful in providing information regarding water quality, differential growth pattern in various age groups, spawning, relative fatness and well being of fishes. If, however, the weight increases more rapidly than the cube of length, K would increase with increase in length. When the increment in weight is less than the cube of length, K would tend to decrease with the growth of the fish. Hile [6] and Martin [7] opined that the condition factor or ponderal index or relative condition factor (Kn) is an expression used to assess the condition of fish, and Kn value 1 or greater than 1 is regarded as well being of fish. Most of the workers have observed that the condition factor of fish depends upon the availability and composition of food and the physico-chemical characteristics of water [28-30]. Jhingran [31] has worked out the condition factor of some freshwater fishes without making reference of pre-and post-spawning of fish and found that environmental factors besides physiological factors are influencing the coefficient of condition in freshwater fishes. A decline in the value of 'K' towards the onset of sexual maturity has been recorded in horse-mackerel, *Caranx kalla* and carp, *C. mrigala* has been observed [32, 33]. *C. catla* had higher value of 'K' in Tighra reservoir than in Ramaua reservoir as this water body had better nutrient level, production of fish food organisms and greater depth which influenced the growth of fish [28]. Chaudhary *et al.* [34] have reported the oscillation in 'K' value of *L. calbasu* between 1.15 and 1.26, thus considered as well being of fish. *L. rohita* fingerlings reared in 50% and 100% sewage water had better growth and higher condition factor as they contained more of nutrients and availability of food organisms [35]. While studying relative condition factor it is found that these values were lower in males while higher in case of females of snake eel, *Pisodonophis bora* and mud eel, *Monopterus cuchia* respectively [36,37]. In golden mahseer, *Tor putitora,* a variations in the condition of the fish during its growth was found [38]. The value of 'K' increased proportionately with the length of this fish. Further, the increase and decrease in K values with the increasing length may be due to metabolic strain during maturation and spawning as well as changes in feeding activity.

Mortuza and Rahman [21] have studied condition factor of a freshwater fish, *Rhinomugil corsula* but could not point out which factors responsible for the fluctuation of male and female population distribution in Rajshahi in, Bangladesh. The 'K' values in all the four species (rohu, catla, mrigal and common carp), thus clearly indicated the suitability of the environment, fish food organisms, better nutrient level, organic production and good growth [22]. Sanwal *et al.* [39] have found lowest average value of 'K' in winter and highest in spring season, lowest value during winter season was probably due to the feeding availability, feed intake or stress due to low temperature in Bhimtal. The relative condition factor for adult groups of *Ompak bimaculatus* and *Ompak malabricus* indicates that both the species have grown well in the environment Arthi *et al.* [40]. Renuka and Bhat [41] have found that the relative condition factor of male and female of *Gerres filamentosus* showed that 'Kn' values were more or less similar in the both sexes and the condition may be related to sexual cycle or feeding intensity and perhaps to several other unknown factors. The relative condition factor of *S. esomus* revealed that the fluctuations in 'Kn' values can be attributed to the spawning cycle as well as the feeding intensity [27]. This observation with regard to condition factor is in complete conformity with the findings of several authors [22,27,34-38,40,41].

The absolute growth rates have also been found useful in determining the growth of fishes [42]. The absolute growth of fishes has increased constantly in carps grown in 100 percent river water after 60 and 120 days of experimentation [35]. The absolute growth has also been found better in *L. rohita* and *C. catla* in comparision to *C. mrigala* and *C. carpio* in polyculture pond at government fish farm, Gwalior [22]. Such observations were also confirmed by several authors [22,35,42] in their studies.

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