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Biometric studies of two gobids *Boleophthalmus boddarti* (Pallas, 1770) and *Boleophthalmus dussumieri* (Valenciennes, 1837) from Mumbai coast, India

Ruhi Jaiswar, Bhavita Chavan and PP Srivastava

Abstract
In the present study, various morphometric and meristic characters of *Boleophthalmus boddarti* (Pallas, 1770) and *B. dussumieri* (Valenciennes, 1837), commercially and ecologically important gobids, is studied. Significantly high values of correlation coefficient were estimated for various compared characters. Similarly, the regression coefficient that determines the growth rate of a species also varied. The length-weight relationship indicates allometric relationship and high degree of homogeneity; whereas negative relationship is attributed to slender longer body growth within the populations. Both the species showed positive as well as negative allometric growth for different morphometric characters. The values of Fulton's condition factor ʻK', indicate poor condition of the fishes but as the fish grows the ʻK' value increases thereby indicating better conditions with increasing adaptability of the environment by these fishes.

Keywords: Gobids, regression coefficient, allometric relationship, Fulton's condition factor

1. Introduction
Morphometric traits are continuous characters describing aspects of body shape whereas meristic is the number of discrete, serial repeated and countable structures, fixed during embryonic or larval stage [1]. These characters play important role in taxonomic identification of any species and have been commonly used in fishery biology to measure discreteness and relationships among various taxonomic categories [2]. In fish, morphometric characters represent one of the major keys for determining their systematics, growth variability, ontogenic trajectories [3] and various population parameters [4]. Morphometric analysis is a powerful tool for characterizing strains of the same species, which involves detection of a subtle variation of shape, independent of size. Morphometric and meristic parameters have been most frequently used to delineate the stocks of fish species [5-8] and to compare different populations of the same species in different environments [9].
Similarly, a mathematical representation of length-weight relationship derived from the study of different sexes and sizes from a particular area is very useful tool for study of biology, physiology, ecology, population dynamics, fisheries assessment, and general conditions of the studied population [10- 12]. Besides, it can also be used in fitting yield equation for estimation of a number of fish landed and comparing the spatio-temporal wellbeing of the populations [13], and population assessment [14]. Any deviation from the established relationship indicates variation in the ecology of the habitat or physiology of the fish or both [10].
Oxudercine forms most notable group among the amphibious gobies, consists of at least 40 species [15]. The gobids, *B. boddarti* (Pallas, 1770) and *B. dussumieri* (Order- Perciformes; Family-Gobiidae) are distributed along the mudflats of estuary and mangrove area where they construct borrows in soft mud along the intertidal zone of Indo-West Pacific, from India to New Guinea and north to china, Iraq, Pakistan and India [16]. Being amphibious and locomotive in nature, these mudskippers feed very actively in the mudflats during low tide. In India, the two species are available throughout the year; however, they are abundant in markets as food fish during the fishing ban (monsoon). Further, these fishes are very important as experimental animals due to their euryhaline, eurythermal and amphibious nature. But there is no published information on morphometric and meristic traits, length-weight relationship and population characteristics of the two species from Maharashtra coast, India. Hence, the present

investigation was undertaken to study the morphometric and meristic characteristics and to establish the length-weight relationship of *B. boddarti* and *B. dussumieri* found along the Mumbai coast of India.

2. Material and methods

For the present study, specimens of *B. boddarti* were collected from Uran jetty area of the Elephanta caves island, while that of *B. dussumieri* were collected from Bhayander creek area, Mumbai during January 2017 to May 2018. Freshly caught specimens were transported to laboratory. These fishes were thoroughly washed under running tap water and wiped using blotting paper. Various morphometric characteristics were measured for 104 specimens of each species by Vernier Caliper to the nearest of 1mm and the weight was measured by digital balance to an accuracy of 0.01g, following Lagler *et al*. [17], Grant and Spain [18]. The size of *B. boddarti* and *B. dussumieri* ranged from 70-160mm and 100-180mm in length and 10-30gm and 5-35gm in weight, respectively. A total 25 morphometric characteristics including Standard length (SL), Snout length (SnL), Head length (HL), Body depth (BD), Head depth (HD), Eye diameter(ED), Post-orbital length (POL), Inter-orbital length(IOL), Pre-dorsal length (PDL), Dorsal fin base length 1(DFBL1), Dorsal fin base length 2 (DFBL2), Height of dorsal fin (HOD), Post first dorsal fin length(PFDFL), Pre-pectoral length (PPL), Pectoral fin base length (PFBL), Pectoral fin length (PFL), Pre-pelvic length (PPeL), Pelvic fin height (PeFH), Post-head length (PoHL), Pre-anal length (PAL), Anal fin base length (AFBL), Caudal length (CL), Caudal depth(CD) were compared against Total length (TL)(fig 1). The meristic characters studied were number of rays on dorsal fin I, dorsal fin II, pectoral fin, pelvic fin, anal fin and caudal fin.

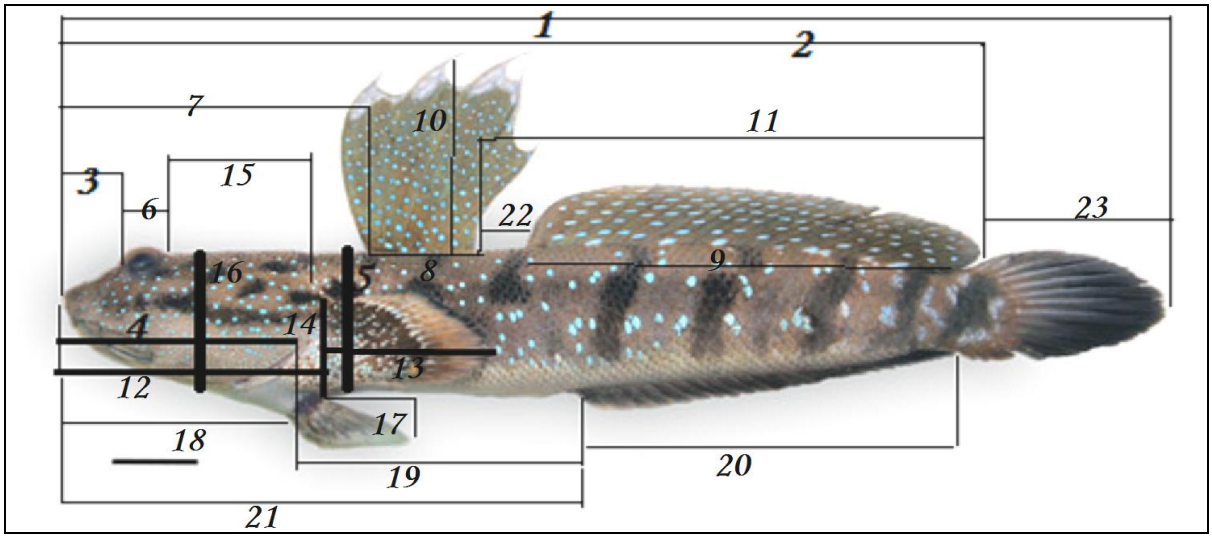

Fig 1: Morphometric measurements (1. Total length, 2. Standard length, 3. Snout length,4. Head length, 5. Body depth, 6. Eye diameter, 7. Pre-dorsal length, 8. Dorsal fin base length1, 9 Dorsal fin base length2, 10. Height of dorsal fin, 11. Post first dorsal fin length 12. Pre-pectoral length, 13. Pectoral fin length 14.Pectoral fin base length, 15. Post orbital length, 16. Head depth, 17. Pelvic fin height, 18. Pre-pelvic length, 19. Post head length, 20. Anal fin base length, 21. Pre-anal length, 22. Distance between 1st and 2nd dorsal fin length, 23. Caudal depth)

Measured characters were subjected to standard statistical analysis including range, mean, mode, standard deviation, standard error, variance and coefficient of variance. The relationship between different morphometric characters was established by using standard formula [17-21]. The length-weight relationship was fitted by exponential curve as per the formula [22], $W = aL^b$. This equation can also be expressed in its logarithmic form log W=loga + blogL, where, W=total weight (g), L=total length (mm), a=intercept (initial growth coefficient or condition factor), b=slope (growth coefficient, *i.e.* relative growth of fish). The parameters a and b of length-weight relationship were estimated by linear regression analysis (least square method) on log transformed data and the degree of association, between variables (W and L), was calculated by the coefficient of determination (r^2). Additionally, 95% confidence limits of the parameters a and b and the statistical significance level of r^2 were estimated.

The relationships were represented by the equation: Y=a+bX

Where, "Y" is dependent variable, "X" independent variable, "a" constant (intercept) and "b"-the regression coefficient (slope). The "a" and "b" were determined as follows,

$$a = y - bx; \qquad b = [n\sum xy - \sum x \sum y]/[n \sum x2 - (\sum x2)]$$

The correlation coefficient (r) is usually calculated to express the degree of linear association or interdependence of two variables as: $r = [n\sum xy - \sum x\sum y]/\sqrt{[n\sum x2 - (\sum x2)]\ [n\sum y2 - (\sum y2)]}$.

All the statistical analysis was performed using statistical software STATISTICA.

The condition factor (K) was calculated based on the formula

$$K = W*100/L3 \text{ ----- Fulton } [23]$$

Where, K = condition factor; W = weight of the fish in grams; L = length of the fish in mm.

3. Results and discussion

The descriptive statistics mean, mode, median, range, standard deviation, standard error and coefficient of variation (%) of various morphometric characters are have shown variations in values for the two species (table 1a and 1b). The Inter orbital length showed a maximum coefficient of variation of 58.56 while minimum of 17.52 was shown by head length in *B. boddarti*. Similarly, for *B. dussumieri* maximum coefficient of variation was obtained for Inter orbital length (124.34) and minimum for head length (10.89). Growth seems to exhibit a significant effect on the Inter orbital length in both the species.

Table 1(a): Statistical estimate of various morphometric characters of *B. boddarti*

S. No.	Range		Mean (mm)	Median (mm)	Mode (mm)	Standard Error (mm)	Standard Deviation (mm)	Coefficient of Variation (%)
	Min (mm)	Max (mm)						
1	2.00	31.0	16.17	11.0	20.0	0.75	8.48	47.33
2	72.00	163.0	126.16	120.0	150.0	2.39	32.52	19.33
3	61.00	137.0	106.12	99.5	114.0	1.99	24.74	19.21
4	2.57	8.95	5.52	5.06	5.60	0.13	1.88	24.82
5	13.65	33.3	24.61	20.18	27.9	0.42	1.86	17.51
6	5.20	25.6	16.31	16.51	16.6	0.39	8.18	24.95
7	7.40	22.3	14.69	14.38	16.3	0.34	6.81	24.03
8	1.11	6.50	3.30	2.52	4.50	0.12	1.10	38.18
9	10.25	39.9	17.17	14.26	13.64	0.39	1.03	23.61
10	0.21	3.30	0.93	1.25	1.00	0.05	0.98	58.56
11	19.66	50.1	34.77	31.79	36.8	0.63	5.09	18.64
12	3.22	20.19	9.93	10.55	12.0	0.27	1.47	28.15
13	24.50	53.2	40.29	41.03	38.0	0.70	2.50	17.96
14	14.50	69.0	40.70	39.28	47.4	1.23	20.10	30.87
15	30.68	82.3	59.54	58.74	63.5	1.19	17.14	20.54
16	5.66	19.9	11.27	11.0	14.2	0.31	6.53	28.35
17	19.54	47.8	34.80	30.89	37.8	0.70	7.36	20.52
18	3.82	16.3	8.92	9.69	8.70	0.25	3.69	28.87
19	5.35	19.1	10.50	13.22	9.50	0.34	7.03	33.47
20	15.10	43.1	27.75	27.30	34.7	0.57	6.64	21.11
21	6.36	34.9	14.46	18.97	11.9	0.75	13.33	53.21
22	22.53	72.8	43.08	45.06	51.3	1.17	22.82	27.80
23	22.21	90.1	59.67	61.77	59.8	1.34	25.06	22.91
24	24.20	64.2	41.81	44.85	44.9	0.97	17.60	23.87
25	11.00	28.0	20.03	20.5	23.0	0.45	7.77	23.36
26	3.77	25.9	10.12	14.96	8.00	0.58	11.93	58.48

Table 1(b): Statistical estimate of various morphometric characters of *B. dussumieri*

S. No.	Range		Mean (mm)	Median (mm)	Mode (mm)	Standard Error (mm)	Standard Deviation (mm)	Coefficient of Variation (%)
	Min (mm)	Max (mm)						
1	5.00	35.0	11.37	10.0	9.00	0.49	12.72	43.73
2	100.0	177.0	123.28	120.0	118.0	1.36	29.69	11.31
3	84.0	145.0	100.34	98.5	100.0	1.05	26.87	10.76
4	3.44	8.04	5.56	5.43	5.33	0.09	0.68	16.93
5	13.12	30.73	23.23	22.66	24.08	0.24	2.80	10.89
6	9.75	20.8	13.26	13.13	13.49	0.18	3.16	13.89
7	1.70	17.0	11.42	11.27	13.00	0.17	3.42	15.84
8	1.09	4.60	2.27	2.20	2.20	0.05	0.04	25.14
9	13.31	21.55	16.31	16.02	15.99	0.15	1.41	9.42
10	0.11	3.80	0.55	0.36	0.40	0.06	2.35	124.34
11	21.36	47.23	32.53	32.23	34.04	0.39	5.58	12.30
12	9.70	24.75	16.80	16.44	18.00	0.25	0.50	15.57
13	14.7	61.85	42.39	42.42	43.14	0.54	14.28	13.14
14	12.37	26.19	18.48	18.23	15.6	0.22	0.91	12.59
15	14.33	70.17	50.34	49.97	52.57	0.67	10.26	13.63
16	23.8	43.65	30.93	30.48	27.4	0.36	1.37	12.00
17	4.17	11.65	7.38	7.32	8.48	0.13	0.76	18.22
18	5.35	21.80	10.06	9.54	8.32	0.26	5.44	26.77
19	20.4	37.22	25.15	24.89	27.6	0.27	3.33	11.10
20	4.81	17.80	11.06	10.84	10.05	0.19	5.04	17.54
21	24.33	87.41	37.33	36.66	40.3	0.67	10.01	18.31
22	33.03	81.00	53.93	53.22	#N/A	0.63	12.50	12.05
23	33.19	53.77	39.81	39.5	40.8	0.38	7.70	9.81
24	10.00	39.00	22.95	22.0	20.0	0.43	2.82	19.24
25	4.59	10.74	7.28	7.19	8.70	0.11	1.76	16.30

Examination of meristic characters revealed the variations in number of rays on the pectoral fin (13-14), pelvic fin (9-10), anal fin (24-25) and caudal fin (13-14) whereas the rays on dorsal fin-i (5), dorsal fin–ii (25) were constant in *B. boddarti*. Similarly, in the *B. dussumieri*, variation was seen in number of rays on pectoral fin (17-18) and anal fin rays (26-28) while rays on dorsal fin -i (5), dorsal fin-ii (28), pelvic fin rays (10) and caudal fin (13) were constant. Coefficient of variation was maximum (7.443229) for pelvic fin rays among all the meristic characters and minimum in Anal fin rays (2.88615) in *B. boddarti.* (Table 2a); whereas for *B. dussumieri* maximum value of coefficient of variation was seen in Anal fin rays (5.237828) and minimum, in pectoral fin rays (4.04061) (Table 2b). The values mean, median, mode, standard error, standard deviation and coefficient of variation indicated a high degree of homogeneity within the population of both the species. The meristic counts recorded agree well with the range given by other authors for *B. boddarti* as well as *B. dussumieri*. The difference in meristic count indicates that different locations and environment have a considerable

impact on meristic characters, where interaction between genetics and environment occurred [24, 11]. The correlation coefficient (r) between different morphometric characters ranged from 0.988 to 0.216 in *B. boddarti* and 0.937 to 0.001 in *B. dussumieri* indicating the various degree of correlation among the different characters compared. Among the morphometric characters compared against total length (Table-3a and 3b), the 'b' values indicate highest growth rate for standard length in both the species. Maximum correlation was shown by standard length (0.988) and minimum caudal depth (0.216) in *B. boddarti* whereas the maximum coefficient

Table 2(a): Details of various meristic characters of *B. boddarti*

S. No.	Meristic characters	Range		Mean	Median	Mode	Standard error	Standard deviation	Coefficient of variance (%)
		Min	Max						
1	Dorsal fin ray 1	5	5	5	5	5	-	-	-
2	Dorsal fin ray 2	25	25	25	25	25	-	-	-
3	Pectoral fin ray	13	14	13.5	13.5	13.5	0.09	0.70	5.23
4	Pelvic fin ray	4	5	4.98	4.5	5	0.01	0.70	2.77
5	Anal fin ray	24	25	24.5	24.5	24.5	0.5	0.70	2.88
6	Caudal fin ray	13	14	13.5	13.5	13.5	0.5	0.70	5.23

Table 2(b): Details of various meristic characters of *B. dussumieri*

S. No.	Meristic characters	Range		Mean	Median	Mode	Standard error	Standard deviation	Coefficient of variance (%)
		Min	Max						
1	Dorsal fin ray 1	5	5	5	5	5	-	-	-
2	Dorsal fin ray 2	28	28	25	25	25	-	-	-
3	Pectoral fin ray	17	18	17.5	17.5	17.5	0.5	0.70	4.04
4	Pelvic fin ray	4	5	4.98	4.5	5	0.01	0.70	2.77
5	Anal fin ray	26	28	27	27	27	1	1.41	5.23
6	Caudal fin ray	13	13	13	13	13	-	-	-

of variation was shown by *B. dussumieri* for standard length (0.937) and minimum for pectoral fin length (0.001). The regression coefficient value 'b' of the length-weight relationship is the most important parameter, which explains the growth pattern of fish [25], that the fish grows symmetrically or isometrically (provided the specific gravity remains constant). The value of 'b' greater than 3 indicates positive allometric growth as large specimens have increased in width at a greater rate than in length [10]. Fishes having b value as 3 maintain their specific body shape throughout their life. The growth pattern of some morphometric characters was shown to be species specific patterns such as body allometry. The profiles of the middle part of the body were always found to be deeper, something that is necessary for manoeuvring (quick starts and rapid turns) [26]. The noticeable growth in the abdominal region suggests greater development of the intestine [27], a finding similar to other studies that have shown that the middle part of the body increases later throughout ontogeny (after head and tail) in bilateral species [28, 29], as opposed to asymmetrical species. The other negative allometric patterns of different morphometric characters obtained in this study imply that the fish becomes more slender as it becomes longer where large specimens have increased in length more rapidly than width, or small specimens were in better nutritional condition, which is common phenomenon [30, 25, 31].

Table 3(a): Values of constants a and b in the linear regression of various characters on the total length with the respective r^2 values of *B. boddarti* (*Bb*) and *B. dussumieri* (*Bd*)

S. No.	Morphometric characters/Total length	A		B		r^2	
		Bb	***Bd***	***Bb***	***Bd***	***Bb***	***Bd***
1	Standard length	1.154	7.882	0.832	0.749	0.988	0.937
2	Snout length	0.415	0.565	0.040	0.040	0.524	0.360
3	Head length	4.048	4.678	0.163	0.150	0.851	0.688
4	Body depth	1.295	1.033	0.139	0.116	0.700	0.770
5	Head depth	1.164	0.122	0.125	0.091	0.753	0.499
6	Eye diameter	1.675	0.630	0.039	0.013	0.588	0.105
7	Post-orbital length	2.083	4.768	0.119	0.093	0.518	0.721
8	Inter- orbital length	0.948	2.196	0.015	0.022	0.441	0.201
9	Pre-Dorsal length	6.479	4.386	0.221	0.228	0.548	0.632
10	Dorsal fin base length1	2.641	221.0	0.058	-1.545	0.262	0.024
11	Dorsal fin base length2	9.352	3.912	0.245	0.312	0.684	0.610
12	Height of dorsal fin	11.55	6.981	0.414	0.093	0.649	0.312
13	Post 1st dorsal fin length	0.532	0.406	0.476	0.405	0.901	0.676
14	Pre –Pectoral length	1.012	7.857	0.267	0.187	0.837	0.494
15	Pectoral fin base length	0.779	0.053	0.064	0.060	0.376	0.391
16	Pectoral Fin length	0.154	46.8	0.084	-0.221	0.348	0.001
17	Pre-Pelvic length	0.602	3.230	0.215	0.177	0.806	0.787
18	Pelvic Fin height	5.614	0.085	0.159	0.089	0.255	0.409
19	Post-Head length	7.113	11.64	0.398	0.208	0.656	0.180
20	Pre-Anal length	3.456	3.511	0.500	0.408	0.797	0.77
21	Anal fin base length	0.728	11.25	0.325	0.231	0.634	0.684
22	Caudal length	1.154	7.882	0.167	0.250	0.772	0.623
23	Caudal Depth	4.108	0.428	0.113	0.062	0.216	0.539

Table 3(b): Length-weight relationship with respect to b value where PA- Positive allometric growth NA- Negative allometric growth

S. No.	Compared against TL	b value		Relationship	
		B. boddarti	***B. dussumieri***	***B. boddarti***	***B. dussumieri***
1	Standard length	0.832	0.749	PA	PA
2	Snout length	0.040	0.040	NA	NA
3	Head length	0.163	0.150	NA	NA
4	Body depth	0.139	0.116	NA	NA
5	Head depth	0.125	0.091	NA	NA
6	Eye diameter	0.039	0.013	NA	NA
7	Post-orbital length	0.119	0.093	NA	NA
8	Inter- orbital length	0.015	0.022	NA	NA
9	Pre-Dorsal length	0.221	0.228	NA	NA
10	Dorsal fin base length1	0.058	-1.545	NA	NA
11	Dorsal fin base length2	0.245	0.312	NA	PA
12	Height of dorsal fin	0.414	0.093	PA	NA
13	Post 1st dorsal fin length	0.476	0.405	PA	PA
14	Pre –Pectoral length	0.267	0.187	NA	NA
15	Pectoral fin base length	0.064	0.060	NA	NA
16	Pectoral Fin length	0.084	-0.221	NA	NA
17	Pre-Pelvic length	0.215	0.177	NA	NA
18	Pelvic Fin height	0.159	0.089	NA	NA
19	Post-Head length	0.398	0.208	PA	NA
20	Pre-Anal length	0.500	0.408	PA	PA
21	Anal fin base length	0.325	0.231	PA	NA
22	Caudal length	0.167	0.250	NA	NA
23	Caudal Depth	0.113	0.062	NA	NA

The meristic characters of both the species were found to be in the range described by the earlier workers [15, 34, 35] (Table 4). However, number of pectoral fin rays was found to be lesser (13-14) than earlier description (16-17) in the case of *b. boddarti*.

Length - weight relationship of *B. boddarti* has been established as

Log W= -1.3036+0.2842 Log L……..…….. (Male)

Log W= -1.3877+0.3269 Log…...…….. (Female)

Log W= -1.3333+0.2988 Log L…….. (Pooled)

Length – weight relationship of *B. dussumieri* was estimated as

Log W= -1.0130+0.2069 Log L……..…….. (Male)

Log W= -1.3877+0.3269 Log L..…… (Female)

Log W= -1.473+0.332 Log L…….. (Pooled)

Table 4: Meristic characters of *B. boddarti* and *B. dussumieri* described by different authors

S. No	Meristic characters	Branchiostegal rays	Dorsal fin ray		Pectoral fin ray	Pelvic fin ray	Anal fin ray	Caudal fin ray	Lateral line scales	Lateral line scales transverse
			I	II						
B. boddarti										
1	Day [34]	5	5	24-25	17	1/5	24	13	70	19-21
2	Talwar & Jhingran[35]	-	5	23-27	16-17	-	23-27	-	-	-
3	Murdy [15]	-	-	24-26	-	-	-	-	61-79	-
4	Present study (2017)	5	5	25	13-14	4-5	24-25	13-14	-	-
B. dussumieri										
1	Day [34]	5	5	27-28	19	1/5	26	13	125	-
2	Talwar & Jhingran [35]	-	5	26-27	17-18	-	25	-	-	-
3	Murdy [15]	-	-	24-28	-	-	-	-	91-136	-
4	Present study (2017)	5	5	28	17-18	4-5	26-28	13	-	-

The present results of length – weight relationship proves the significant difference between both the sympatric species and their growth rate in pooled data and when the sexes are separated. All the morphometric indices show moderate correlation value for male and female of both the species studied. This indicates that the different morphometric indices do not grow as the same growth rate of the total length of the fish. The variations in different morphometric characters compared to the total length perhaps are owing to the geographical and ecological conditions which lead to difference in water quality parameters and food availability of the habits or variation in the physiology of the animals, or both, could be responsible for the growth of the fish [22].

Condition factor ‘K' is used as an index of fitness of an individual or stock, which is different for different fish stocks. In the present study, the resultant ‘K' value ranged from 0.39 to 0.73 in *B. boddarti* and 0.38 to 0.74 in *B. dussumieri* (Table 5). Based on the studies of Salomon, Barnham & Baxter [32] opined that the condition factor ‘K' greater than 1.4 indicates good or well-proportioned fish and the K value less than 1 indicates poor quality of fish resembling big head with thin body which is associated with reproductive cycle, poor feeding and various environmental factors [33]. Also in these species, as there is an increase in the growth rate substantial boost in the ‘K' value can be seen.

Table 5: Fulton's condition factor: $K=W*100/(L)^3$

S. No.	Length range	Average length	Weight range	Average weight	K	Condition
B. boddarti						
1	72-102	89.86	2-10	6.77	0.39	Poor
2	103-132	115.84	11-20	17.29	0.69	Poor
3	133-163	145.67	21-31	23.92	0.73	Poor
B. dussumieri						
1	100-125	116.48	5-15	8.44	0.38	Poor
2	126-150	136.4	16-25	13.8	0.52	Poor
3	151-177	173.33	26-35	29	0.74	Poor

The poor condition of the fish is owing to the extremely polluted habit which is continuously being more exposed to different effluents each day thereby deteriorating the condition of the water body and hampering the sustainable growth of the flora and fauna thriving in it.

4. Conclusion

The study indicates increasing pollution in the natural habitats of these species. The situation needs to be looked in to; else these species will become endangered.

5. References

1. Kumar T, Chakraborty SK, Jaiswar AK, Sandhya KM, Panda D. Biometric studies on *Johnieops sina* (Cuvier,1830) along Ratnagiri coast of Maharashtra. Indian J Fish. 2012; 59(1):7-13.
2. Quilang JP, Basio ZU, Pagulayan RC, Roderos RR, Barrios EB. Meristic and morphometric variation in the silver perch, *Leiopothera ponplumbeus* Kner, 1864) from three lakes in the Philippines. J Appl. Ichthyol. 2007; 23:561-567.
3. Kovac V, Copp GH. Morphometry of the stone loach *Barbatula barbatula* (L). Do metric characters reflect the species' life history thresholds? Environ. Biol. Fish. 1999; 56:105-115.
4. Sandhya KM, Chakraborty SK, Jaiswar AK, Kumar T, Mohite S. Morphometry and length-weight relationship of *Otolithes cuvieri* (Trewavas, 1974) from Ratnagiri waters, Maharashtra, north-west coast of India. Indian J Fish. 2015; 62(4):99-103.
5. Murta AG. Morphological variation of horse mackerel (*Trachurus trachurus)* in the Iberian and North African Atlantic: Implications for stock identification. ICES J Mari. Sci. 2000; 57:1240-1248.
6. Silva A. Morphometric variation among sardine *(Sardina pilchardus)* populations from the north eastern Atlantic and the western Mediterranean. ICES J Mari. Sci. 2003; 60(6):1352-1360.
7. O'Reilly KM, Horn MH. Phenotypic variation among populations of *Atherinops affinis* (Atherinopsidae) with insights from a geometric analysis. J Fish. Biol. 2004; 64:1117-1135.
8. Turan C. Stock Identification of mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters. ICES J Mar. Sci. 2004; 61:774-781.
9. Gonçalves JMS, Bentes L, Lino PG, Ribeiro J, Canário AVM, Erzini K. Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and southwest coast of Portugal. Fish. Res. 1997; 30:253-256.
10. Jaiswar AK, Parida PK, Chakraborty SK, Palaniswamy R. Morphometry and length-weight relationship of obtuse barracuda *Sphyraena obtusata* (Cuvier) (Teleostomi /Actinopterygii / Sphyraenidae) from Bombay waters, west coast of India. Indian J Mari. Sci. 2004; 33(3):307-309.
11. Swain DP, Foote CJ. Stocks and chameleons; the use of phenotypic variation in stock identification. Fish. Res. 1999; 43:23-128.
12. Cadrin SX. Advances in morphometric analysis of fish stock structure. Rev. Fish Biol. Fish. 2000; 10:91-112.
13. Beverton RJH, Holt SJ. On the dynamics of exploited fish populations. Fish. Invest. Min. Agric. Fish Food G.B. (2.Sea Fish.) Reprinted 1993.Chapman and Hall Fish. Ser.11. 1957, 533.
14. Ricker WE. Methods for assessment of fish production in fresh waters, International Biological programme (Blackwell Scientific Publications, London). 1968; 3:313.
15. Murdy E. A taxonomic revision and cladistic analysis of the Oxudercine gobies (Gobiidae: Oxudercinae). Res. Australian mus. suppl. 1989; 1:1-93.
16. Fishbase; http://www.fishbase.org/summary/4901.
17. Lagler KF, Bardach IE, Miller RR. *Ichthyology* (The study of fishes). John Wiley, New York, 1962, 545.
18. Grant CJ, Spain AV. Variation in the body shape of three species of Australian mullets (Pisces: Mugillidae) during the course of development. Aust. J Mar. Res. 1977; 29:55-63.
19. Laevastu T. Manual of Methods in Fisheries biology, fascicules.1, 2, 9 and 10, FAO. Rome, 1965.
20. Lowe-Mc Connell RH. Identification of freshwater *fishes*. In: Ricker. W. E. (Ed.), Methods for assessment of fish production in fresh waters, Blackwell Scientific, Oxford and Edinburg, 1971, 45-81.
21. Dwivedi SN, Menezes, Maria R. A note on the morphometry and ecology of *Brachiurus orientalis* (Bloch and Scheneder) in the estuaries of Goa. Geobios. 1974; 1(4):80- 83.
22. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch. *Perca fluviatilis*. J Anim. Ecol. 1951; 20(2):201-219.
23. Fulton TW. The rate of growth of fishes. 20th Annual Report of the Fishery Board of Scotland. 1902; (3):326-446.
24. Marr JC. The subpopulation problemin the pacific sardine, *Sardinops caerulea*. United States Fisheries and Wildlife Series of Special Science Report of Fisheries. 1957; 208:25-108.
25. Froese R. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. J Appl. Ichthyol. 2006; 22:241-253.
26. Webb PW. Body form, locomotion and foraging in aquatic vertebrates. American Zoologist. 1984; 24:107-120.
27. Elbal MT, Garcia Hernandez MP, Lozano MT, Agulleiro

B. Development of digestive tract of Gilthead Sea bream (*Sparus aurata*, *L.*). Light and electron microscopic studies. Aquaculture. 2004; 234:215-238.
28. Van Snik GMJ, Van Den Boogaart JGM, Osse JWM. Priorities during early growth of fish larvae. Aquaculture. 1997; 155(1-4):249-258.
29. Gozlan RE, Copp GH, Tourenq JN. Comparison of growth plasticity in the laboratory and field, and implications for the onset of juvenile development in sofie, *Chondrostomata*. Environ. Biol. Fish. 1999; 56:153-165.
30. Bagenal T B, Tesch FW. Age and growth. In: Methods for assessment of fish production in fresh waters. (Ed. T. Bagenal): 101-136. IBP Handbook No. 3, Blackwell Science Publications, Oxford, 1978, 365.
31. Baby F, Tharian J, Abraham KM, Ramprasanth MR, Ali A, Raghavan R. Length-weight relationship and condition factor of an endemic stone sucker, *Garra gotyla stenorhynchus* (Jerdon, 1849) from two opposite flowing rivers in southern Western Ghats. Jo TT. 2011; 3(6):1851-1855.
32. Barnham PSMC, Baxter A. Condition factor, K, for salmonid fish. Fisheries notes. 1998; (1):1-4.
33. Bolger T, Connolly PL. The selection of suitable indices for the measurement and analysis of fish condition. J Fish Biol. 1989; 34:171-182.
34. Day F. The fishes of India, Vol I (William Dawson & Sons Ltd, London), 1958, 296.
35. Talwar PK, Jhingran AG. Inland fishes of India and adjacent countries. ZSI Publication 2.A.A, 1991.