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Studies on the sex ratio of cat fish, *Sperata aor* (Hamilton, 1822) from Bhadra Reservoir, Karnataka

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Abstract
Sex ratio of catfish, *Sperata aor* was studied from Bhadra reservoir of Karnataka. During the present study, a total of 698 specimens comprising 277 males and 421 females were examined covering wide range of sizes to determine the sex ratio. The total ratio of males to females was about 1:1.51. The chi-square test revealed that no significant difference was observed throughout the year (P>0.05), it was also observed during non-breading season. The data on sex ratio to length also showed that females were dominant (P>0.05) in most of the size groups. The length range of 41-45, 46-50, 51-55, 56-60, 61-65 and 66-70 cm, the females outnumbered males. It was interesting to note that in longer length group (71-75 cm) only females were recorded. The sex ratio in this stock is significantly different from 1:1 ratio in all months. The data of sex ratio of *S. aor* showed that in all the months' females dominated over males.

Keywords: Bhadra Reservoir, sex ratio, *Sperata aor*, chi-square test

Introduction
Sperata aor, is a species of bagrid catfish found in Southern Asia. It grows to a total length of 180 centimeters (71 in) and is commercially used for human consumption. It is also a popular game fish (Froese *et al*, 2011) [6]. Knowledge on reproductive biology of a fish is of great importance in its rational exploitation through proper management of fishery resources, development of selective breeding, brood stock development, domestication and its genetics (Mollykurian and Inasu, 2003) [10]. A study on various aspects of reproduction is essential in the determination of population stock size, periodicity of the strength of broods, fecundity, spawning time and place, and sex composition of exploited stock. Catfishes are considered as one of the most important orders of vertebrates, not only because of more than one-tenth of living fishes are siluriforms, but also because of their relationship with humans covers many aspects of life and culture. Several hundred species are now used as food, and other species will be looked upon as a source of protein in the future. Some species are greatly appreciated as game and commercial fishes and reach high market prices. In addition, most catfishes can be used as aquarium fishes, a business that not only worth millions of dollars, but gives urban populations the opportunity to get in touch with a significant part of nature. The main aim of the present study was to add the information regarding the sex ratio of the catfish, *Sperata aor* from Bhadra reservoir, Karnataka.

Materials and Methods
Study Area
Bhadra reservoir is located close to Lakkavalli village of Tarikere taluk in Chikmagalur district (Figure 1).This water body has been constructed at 601 m above MSL The reservoir is located at latitude 13°42'00" N and longitude 75°38'20"E. The Bhadra basin gets the rainfall ranging from 117 to 573 cm and the temperature varies from 30.14 to 18.76 C. The reservoir is having 186 ft in depth. This is a multipurpose project for irrigation, drinking, fishery and hydroelectric power.

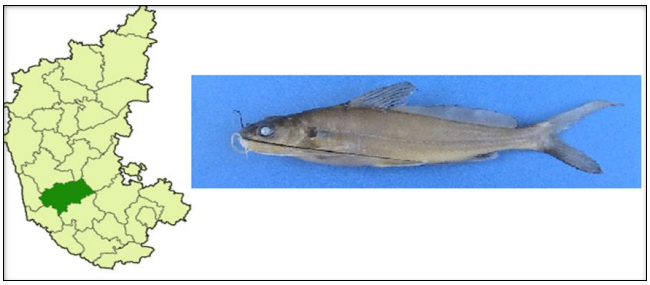

Fig 1: Location of the study area

Sex Ratio
Sex ratio was studied with respect to months and size groups of fish. Data on sex ratio were analysed by % (chi-square χ^2) test using the equation of Fisher (1970), to find out whether dominance of either sex was significant.

Results and Discussion
The month wise sex ratio in *S.aor* during 2003-04 and 2004-05 were pooled and are given in Table 1 and Fig. 2. During the study, a total of 698 specimens comprising 277 males and 421 females were examined covering wide range of sizes to determine the sex ratio. The total ratio of males to females was about 1:1.51. To ascertain whether these samples have intact been drawn from a population where males and females are equally represented, the difference between the observed ratio and the expected ratio of 1:1 has been tested by the chi-square test (Snedecor, 1961) [25].
The data of sex ratio for each month (Table 1) showed that in all the months females dominated over males. The chi-square test (Table 1) revealed that no significant difference

was observed throughout the year (P>0.05), it was also observed during non-breading season (June-August, December-April).

The data on sex ratio to length (Table 2 and Fig.3) also showed that females were dominant (P>0.05) in most of the size groups. The length range of 41-45, 46-50, 51-55, 56-60, 61-65 and 66-70 cm, the females outnumbered males. It was interesting to note that in longer length group (71-75 cm) only females were recorded.

Information on sex ratio is essential in estimating the relative abundance of the sexes. It will also yield information on possible differential growth rates between sexes (Qasim, 1966) [16]. It is believed that the following factors might be responsible for sex composition: (a) Segregation of the sexes through various periods of the year including segregation resulting from sex differences in age and size at maturity, (b) gear selectivity in relation to sex differences in morphology and in physiological activity, and (c) differences between natural and fishing mortality between sexes.

Sexual dimorphism has been reported in S.aor of Ganga river system (Saigal, 1964) [19], males showed a papillary out growth above the urinogenital opening in size above 300 mm which became prominent during breeding season. Such papilla in male have also noted in *Mystus gulio* (Pantulu, 1961) [13], *Mystus tengara* (Parmeshwara, 1970) [14] in *Mystus seengala* (Satyanessan, 1962) [21], *Rita rita* (Saxena, 1972) [22]. No clear cut sexual differentiation could be noted in S aor of Bhadra reservoir. In some specimens genital papillae were noted but on opening the body they were found to be males or females. Hence, the presence of papillae was not a reliable character for sexing S. aor of Bhadra reservoir. Similar condition was observed in S.aor of Bhavanisagar (Ranganadhan and Radha, 1966) [18] and Nagarjunasagar (Ramakrishniah, 1983).

According to Nikolsky (1980) [12] the overall sex ratio in nature is close to 1:1 in the species but it may be far from this to. Thus optimum sex ratio may change drastically as a result of being affected by numerous factors. During the present study it was found that, overall sex ratio of males to females in all 698 specimens being 1:1.51. Chi-square test indicated that this was significant at (P>0.05) from the expected 1:1 ratio. Sex ratio in S aor at different months showed that females outnumbered males. Comparatively the female sex ratio was highest during the months of September and October. This might be due to active movements of the females during spawning. Similar observations were made by Vinci (1984) [26] in *Silonia childreni*, Shendge (2000) [24] in *Cirrhinus reba* and *Puntius sophore* and Pawar and Mane (2006) [15] in *Macrones hleekkeri*. Nevertheless, Bhimasena Rao and Karmachandni (1986) [3] noticed equal population of male and females in *Ompok bimaculatus* from Kulagarhi reservoir (Madhya Pradesh). Qasim (1966) [16] examined the sex ratio in relation to length and age in marine and freshwater species and observed that in general there is a correlation between sex ratio and growth rate; the individuals that attain a greater length due to older age, occur in large numbers. According to this study faster growing sex in the population have a higher survival value in both intra and inter-specific competition for food and space. An analysis of the data on sex ratio in relation to size shows that no males were encountered in samples beyond 71 cm size in reservoir, presumably due to greater mortalities among mature males. And this may suggest a differential growth rate among females as compared that of males. Similar works based on the analysis of sex ratio with respect to size have also reported the dominance of females over males in population of *O. mossambicus* (De Silva, 1986) [4]; *M. cavasius* (Sharma *et al*, 1996) [23]; *C. reba* and *P. sophore* (Shendge, 2000) [24]; *Schizothorax richardsonii* (Madan Mohan, 2005) [8] and *Macrones bleekkeri* (Pawar and Mane, 2006) [15].

The sex structure is also adaptive to the food supply, which influences the reproductive rate and the viability of the offspring (Makeeva and Nikolsky, 1965) [9].The sex ratio varies considerably from species to species but in majority it is close to 1:1. It differs fi-om one population to another of the same species, may vary in the same population from year to year. In river Ganga, Saigal (1964) [19] recorded the predominance of S. aor females throughout the year except in the month of March and the difference in the sex ratio was found to be statistically significant. Natarajan (1983) [11] recorded in Nagarjunsagar the dominance of females in all size groups in *Silonia Childreni* and the overall sex ratio was highly significant with the preponderance of females in ratio of 1:9.3. Such predominance of females in all size groups cannot be explained differential growth. Studies on the sex ratio among fresh water catfish in India showed that *M. aor* {A. aor), (Saigal, 1967) [20], *M seenghala* (Bhat, 1970) [1], *M. gulio* (Pantalu, 1961) [13], *M cavasius* (Bhat, 1971 [2]; Sharma *et al*, 1996) [23], *O. bimaculatus* (Krishna Rao, 1990) [7], *Horabagarus brachysoma* (Molykurian and Inasu, 2003) [10] the females dominated the population as observed in the present study in the stocks *Sperata aor* from the Bhadra reservoir.

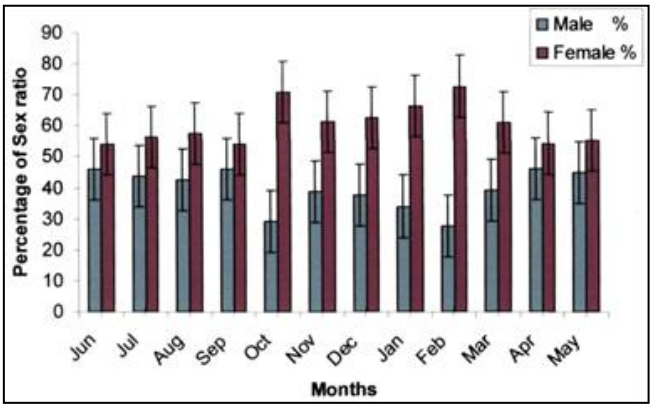

Fig 2: Histogram showing percentage frequency of sex ratio *of S. aor* during different months.

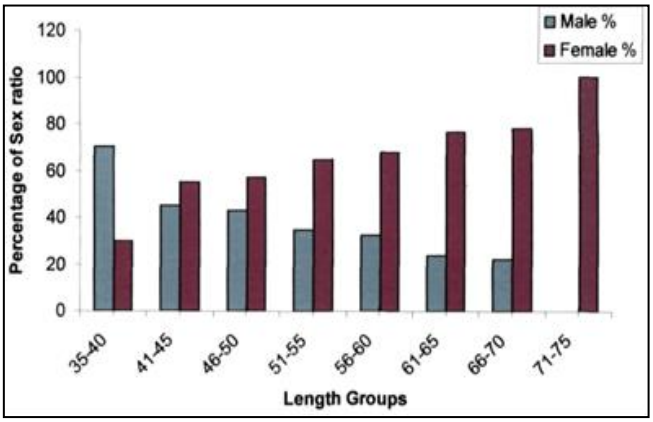

Fig 3: Histogram showing percentage frequency of sex ratio of *S. aor* during different length groups

Table 1: Sex ratio *of S. aor* in different months

Months	No. of specimens (N)	Male (M)	Male %	Female (F)	Female %	Ratio M:F	Chi- square value (y2)
June	76	35	46.05	41	53.95	1: l. 17	0.46**
July	48	21	43.75	27	56.25	1:1.28	0.74**
August	54	23	42.59	31	57.41	1:1.34	1.18**
September	61	28	45.90	33	54.10	l:1.78	0.40**
October	65	19	29.23	46	70.77	l:2.42	11.20**
November	49	19	38.78	30	61.22	1:1.57	3.18**
December	56	21	37.50	35	62.50	1:1.66	3.50**
January	62	21	33.87	41	66.13	1:1.95	6.45**
February	51	14	27.45	37	72.55	1:2.64	10.37**
March	59	23	38.98	36	61.02	1:1.56	2.86**
April	48	22	45.83	26	54.17	1:1.18	0.32**
May	69	31	44.93	38	55.07	1:1.22	0.70**
	698	277	39.68	421	60.32	1.1.51	29.70**

** Non-significant (P>0.05)

Table 2: Sex ratio of *S. aor* in different length groups

Length Groups (cm)	No. of specimens (N)	Male (M)	Male %	Female (F)	Female %	Ratio	Chi-square value ()
35-40	37	26	70.27	11	29.73	1:0.42	6.08**
41-45	158	71	44.94	87	55.06	I:1.22	1.62**
46-50	189	81	42.86	108	57.14	l:1.33	3.84**
51-55	148	52	35.14	96	64.86	1:1.84	13.08**
56-60	96	31	32.29	65	67.71	l:2.09	12.04**
61-65	59	14	23.73	45	76.27	1:3.21	16.28**
66-70	09	02	22.22	7	77.78	1:3.50	2.75**
71-75	02	-	0.00	2	100	0	2”
	698	277	39.68	421	60.32	1:1.51	29.70**

** Non-significant (P>0.05)

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