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Growth and Mortality of *Mystus cavasius* (Hamilton 1822) from Bhadra Reservoir in the Western Ghats, India

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ABSTRACT

The freshwater catfish, *Mystus cavasius* (Hamilton 1822) is a very common food fish and is widely distributed throughout India in rivers and reservoirs. The age and growth and mortality of *M. cavasius* inhabiting the Bhadra reservoir in the Western Ghats of State of Karnataka, India was studied for a period of one year. The standard length of fish ranged from 0.61 to 17.8 cm. The von Bertalanffy growth parameters were estimated using ELEFAN I routine in FiSAT II program and the von Bertalanffy growth equation for length was fitted, $L_t = 21.50\ [1\text{-}e^{-0.56\ (t\ -\ 0.046)}]$. The fish reached the theoretical maximum in about 6 years at the study area. The growth performance index (Φ') was 2.413. The total mortality (Z) was 3.86 year^{-1}. The natural (*M*) and fishing mortality (*F*) rates were 1.35 year^{-1} and 2.51 year^{-1} respectively. The rete of exploitation (0.65 yr^{-1}) of *M. cavasius* at the study area indicates the over exploitation of stock. The data generated will be useful for better management of this fish stock. The data generated will be useful to address the sustainable management of dwindling resource of this species.

Keywords Age and growth, Freshwater catfish, Karnataka, Mortality, Population parameters.

INTRODUCTION

The Gangetic catfish *Mystus cavasius* (Hamilton 1822), belonging to the family Bagridae, is widely distributed in Indian subcontinent (Day 1878, Jayaram 1977) in rivers, canals, ponds, ditches and inundated fields including Karnataka State (Muddanna 1971, Rajagopal *et al.* 1978, Hegde *et al.* 1992; Thippeswamy and Hegde 1999). It is locally called as *Girlu* (in Kannada language) and has high market demand as food fish for fresh consumption. The fishery is based on capture from wild, as in other parts of India (Gupta 2014). A scattered data on age and growth of *M. gulio* from Hooghly estuary, West Bengal (Pantulu 1961), *M. cavasius* from Aligarh, Uttar Pradesh (Bhatt 1971) and *M. aor* from the Nagarjunasagar reservoir in Andhra Pradesh (Ramakrishnaiah 1988) has been reported. *Mystus cavasius* forms one

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of the important catches of Bhadra reservoir and the fish is selectively caught by local fishermen using gillnets for fresh consumption. There is a dearth of information on age and growth, growth parameters and mortality rates of *M. cavasius* inhabiting the freshwater bodies in the Western Ghats region of India. The detailed information generated on the population dynamics of this species in the present study will help us in better management of this fish resource which is based on capture fishery.

MATERIALS AND METHODS

The fishes were collected at monthly intervals from October 2001 to October 2002 from the Bhadra reservoir (13º42' N, 75º38'20" E) and also from fish-landing centers at Hebbe village and other villages located in the backwaters of reservoir and also from Narasimharajapura (N. R. Pura) town situated near the Bhadra reservoir. Fishes were caught by fishermen using gillnets in the Bhadra reservoir. A total of 579 individuals of *M. cavasius* have been subjected to measurements during the study period. The monthly data on standard length (from tip of snout to caudal peduncle) of both males and females was grouped together into 1.0 cm class intervals. Subsequently length frequency data was analyzed using the FiSAT software (Gayanilo *et al.* 1996) and von Bertalanffy growth equation was fitted (Bertalanffy 1938). In the present study the asymptotic length (L_∞) and growth coefficient (K) of the von Bertalanffy Growth Function (VBGF) were estimated by means of ELEFAN-1 (Pauly and David 1981) and the reliable estimate of K value was assessed by K-scan routine. The theoretical time when an animal has zero length (t_0) was also calculated (Bagenal 1955). The length at various ages was estimated by inverse von Bertalanffy growth equation (Sparre and Venema 1992). The VBGF was fitted to estimate length at age curve (Pauly *et al.* 1992). The VBGF was defined by the equation $L_t = L_\infty [1 - e^{-k(t-t0)}]$ where, L_t is the mean length at age t, L_∞ is the mean asymptotic length, K is the body growth coefficient, t is the age and t_0 is the time when $L_t = 0$ (Newman 2002). The estimates of L_∞ and K were used to estimate the growth performance index (Φ') (Pauly and Munro 1984) using the equation $\Phi' = 2 \log_{10} L_\infty + \log_{10} K$ where L_∞ and K are the asymptotic length and growth coefficient of the VBGF. The life span was estimated (Pauly 1983) from the equation $t_{max} = 3/K$ where K is the growth coefficient of the VBGF. The total mortality (Z) was estimated by length converted catch curve method (Pauly 1984). Natural mortality rate (M) was estimated using the empirical relationship of (Pauly1980) and the equation is $\log_{10} M = -0.0066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T$ where, M is the natural mortality, L_∞ and K are the asymptotic length and growth coefficient of the VBGF and T is the mean annual temperature (^{0}C) of ambient environment. The fishing mortality (F) was estimated (Pauly 1980) using the relationship $F = Z - M$. The exploitation level (E) was obtained by the relationship of (Gulland 1971) and the equation is $E = F/Z$ where, $Z = F / F + M$.

RESULTS AND DISCUSSION

Length frequency

The monthly length frequency distribution of fish is presented in Fig. 1. The length frequency distribution showed three peaks at 7-8, 10-11 and 12-13 cm class intervals. The observed lengths during the study period were from 6-7 to 17-18 size classes. The majority of fish were in between 11 and 16 cm sizes and a few individuals were below 11 cm. The fishes might breed during the end of monsoon and early post monsoon seasons as supported by the appearance of young individuals during the post monsoon season. Only one peak was observed during October, November 2001, March, May and September 2002 and two peaks were during April to July 2002 and three peaks during December 2001, February and October 2002. However, during January 2002 four peaks were observed.

Growth parameters

The growth parameters (L_∞, K, t_0) are helpful in comparison of growth rates between and within species inhabiting different habitats. The monthly length frequency distribution with growth curves superimposed using ELEFAN I for *M. cavasius* is presented in Fig. 2. The estimated values of growth parameters of the VBGF such as asymptotic length (L_∞), the growth coefficient (K) and age at birth ($\mathbf{t}_0$) for *M. cavasius* were 21.5 cm, 0.56 year^{-1} and 0.046

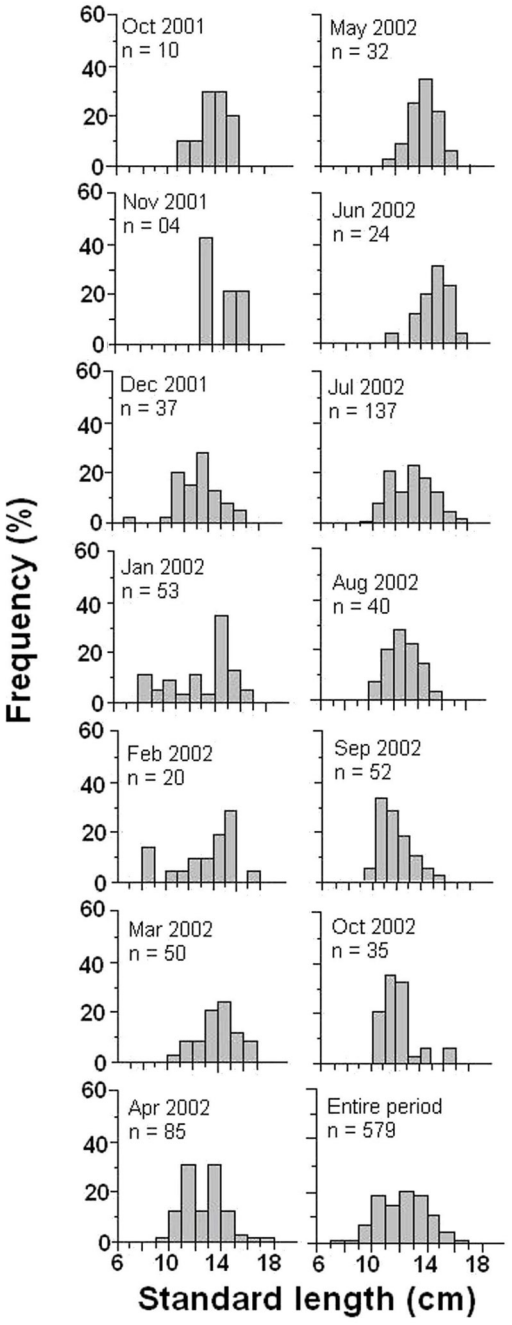

Fig. 1. The monthly length frequency distribution of *Mystus cavasius* from Bhadra reservoir.

month respectively. The maximum theoretical length of an organism can attain under given rate of growth ($L\infty$) of the VBGF of *M. cavasius* was 21.5 cm (Fig.

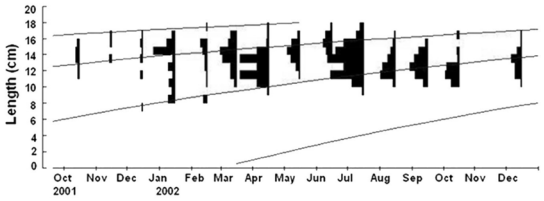

Fig. 2. Length frequency distribution with growth curves of *Mystus cavasius* superimposed using ELEFAN-I.

3). The growth related parameters of freshwater cat fishes from India and elsewhere is presented in Table 1. The present value of $L\infty$ was less than the values reported for *M. gulio* (Pantulu 1961), *M. aor* (Ramakrishnaiah 1988), *Schilbe intermidius* (Etim *et al.* 1999) *S. trigostegus* (Oymak *et al.* 2001), Hemisorubim platyrhynchos (Penha *et al.* 2004), Clarotes laticeps (Abowei and Davies 2009), *Hemisynodontis membranaceus* (Ofori-Danson *et al.* 2001) and *Horabagrus brachysoma* (Prasad *et al.* 2012) (Table 1). The maximum length (L_{max}) recorded was 17.8 cm whereas the predicted maximum length was 18.02 cm. The calculated $L\infty$ (21.5 cm) appears to be realistic estimate in view of the fact that L_{max} for *M. cavasius* from Bhadra reservoir was 17.8 cm. The present L_{max} valve was less than the valves reported for *M. aor* (Ramakrishnaiah 1988), *S. bimaculatue* (Pethiyagoda 1991), *S. trigostegus* (Oymak *et al.* 2001), *H. platyrhynchos* (Penha *et al*. 2004), *S. glans* (Tarakan *et al.* 2006) and *H. brachysoma* (Prasad *et*

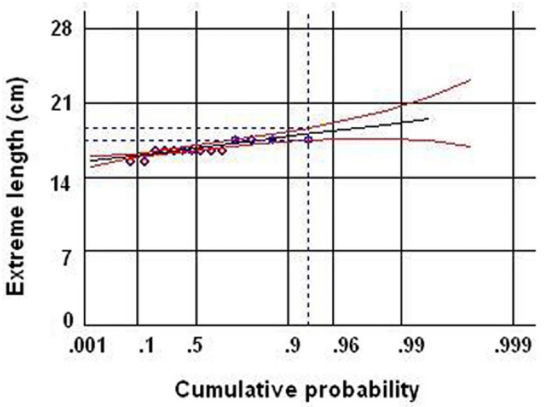

Fig. 3. Prediction of maximum length for *Mystus cavasius* from extreme values from Bhadra reservoir..

Table 1. Growth and mortality related parameters of freshwater catfishes from various geographical regions. Explanation for symbols is described in the text. L_{max}, maximum length; L_{∞}, asymptotic length; *K*, growth coefficient; t_0, theoretical time when an animal has zero length; Φ', growth performance index; *M,* natural mortality; F, fishing mortality; Z, total mortality; E, exploitation level.

Species	L_{max} (cm)	L_{∞} (cm)	*K*	t_o	*Φ'*	*M*	*F*	*Z*	E	Source
Clarotes laticeps	59.1	60.00	0.360	-0.620	2.780	0.87	0.33	1.20	0.27	Abowei and Davies (2009)
Hemisorubim platyrhynchos	64.0	64.00	0.222	-2.148	-	-	-	-	-	Penha *et al*. (2004)
Hemisynodontis membranaceus	-	44.50	0.620	-0.230	-	1.20	-	4.39	0.72	Ofori-danson *et al*. (2001)
Horabagrus brachysoma	-	42.20	0.550	-0.012	4.990	1.04	4.60	5.64	0.82	Prasad *et al.* (2012)
Mystus aor	74.0	86.00	0.230	-0.552	-	-	-	-	-	Ramakrishnaiah (1988)
M. gulio	-	54.47	0.064	-0.209	-	-	-	-	-	Pantulu (1961)
Schilbe intermidius	-	27.50	0.290	-	-	0.81	1.04	1.85	0.56	Etim *et al.* (1999)
Silurus triostegus	99.0	133.40	0.082	-1.693	-	-	-	-	-	Oymak *et al*. (2001)
Mystus cavasius	17.8	21.50	0.560	0.046	2.413	1.35	2.51	3.86	0.50	Present study

al. 2012). The confidence interval was 17.45 – 18.60 cm (95% probability of occurrence). The coefficient *K*, the rate at which the size of animals approaches the theoretical maximum, can be used to compare between growth of related species or more same species in varied habitats. The coefficient, *K* of the VBGF of *M. cavasius* was 21.5 cm (Fig. 4). The best estimated *K* value in the present study was 0.56 year^{-1} which is high as against *M. gulio* (Pantulu 1961), *M. aor* (Ramakrishnaiah 1988), *S. intermidius* (Etim *et al.* 1999), *S. trigostegus* (Oymak *et al.* 2001), *H. platyrhynchos* (Penha *et al.* 2004) and *C. laticeps* (Abowei and Davies 2009) and low as against *H. membranaceus* (Ofori-Danson *et al.* 2001). The present value (*K* = 0.56 year^{-1}) is more or less same as in *H. brachysoma* (Prasad *et al.* 2012) (Table 1). Because, *K* denotes the rate of which the growth decreases to reach the maximum, the lower values of *K* denotes the faster rates of growth. *K* can be used as an intra-inter-specific comparison of growth (Beverton and Holt 1957, Fabens 1965). Of the 3 parameters of von Bertalanffy, the theoretical time when an organism has zero length (t_0) is of only of theoretical interest which in the present study was 0.046 month which is high as against the values reported for freshwater catfishes (Table 1). The computed von Bertalanffy growth curve for length is presented in Fig. 5. The von Bertalanffy growth equation for *M. cavasius* was

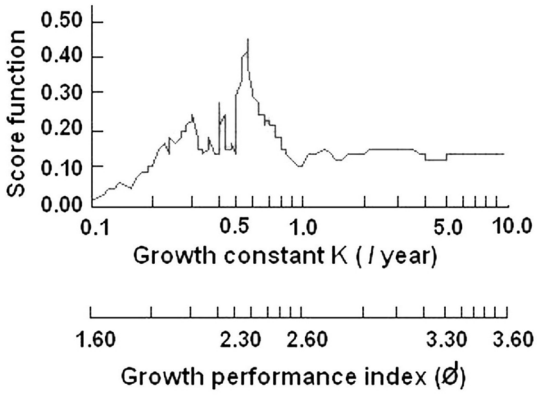

Fig. 4. Estimation of growth constant and growth performance index of *Mystus cavasius* from Bhadra reservoir.

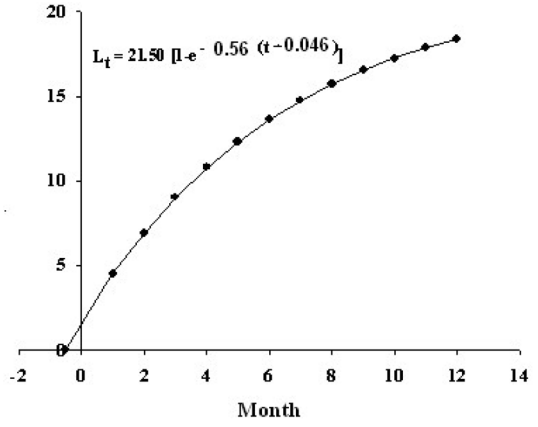

Fig. 5. von Bertalanffy growth curve of *Mystus cavasius* from Bhadra reservoir.

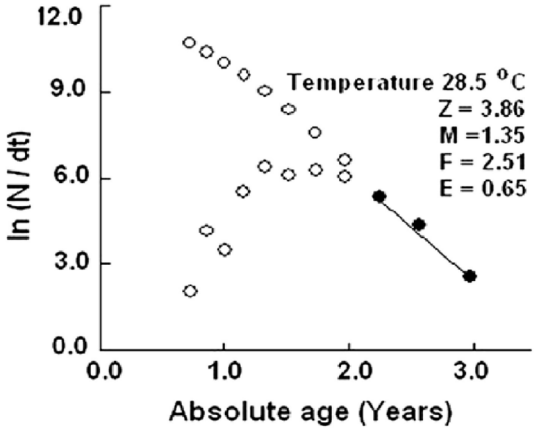

Fig. 6. Length converted catch curve of *Mystus cavasius* from Bhadra reservoir.

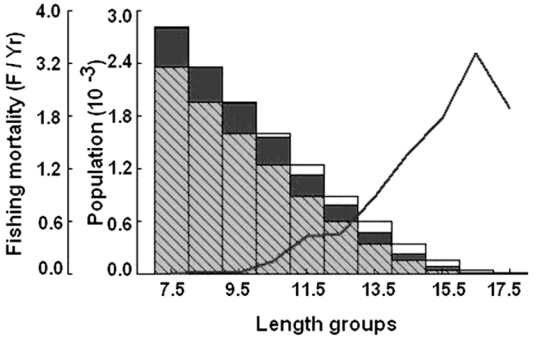

Fig. 7. Length structured virtual analysis of *Mystus cavasius* population from Bhadra reservoir. The dark shaded, not shaded, shaded with lines and line represent catch, natural mortality, survivors and fishing mortality, respectively.

Lt = 21.5 $[^{1-e-0.56(t-0.046)}]$. Fish attained the size of 3.8, 7.5, and 11.2 cm at the end of first, second and third years respectively. The theoretical maximum size of *M. cavasius* attained during its life was 21.5 cm. The life span estimated from the equation t_{max} = 3/K (Pauly 1983) was 5.35 years.

Growth performance index (Phi-prime, Φ')

Growth performance index (Phi-prime, Φ') is a length-based index of growth performance which combines *K* and *L*∞ and was used to give an expression of the growth potential of the species. This value is important for comparing growth performance of the same species or between the species of the same genus. The growth performance index (Φ') of the present study was 2.413. The Phi-prime values for freshwater cat fishes from various geographical regions of the world are presented in Table 1. The growth performance index value of 2.413 calculated in the present study (Fig. 4) is significantly higher than that obtained for many tropical freshwater catfish species including those belonging to the families Schilbeidae (Φ' between 2.18 and 2.78) (Etim *et al.* 1999), Claroteidae (Φ' = 2.32) (Abowei and Davies 2009) and Synodontidae (Φ' = 3.09) (Ofori-Danson *et al.* 2001). As phi prime (Φ'') is largely considered to be a species-specific parameter with their values being similar within related groups or taxa. The values of growth performance index in the present study (Φ'' = 2.413) less than the values reported for *C. laticeps* (Φ'' = 2.780) (Abowei and Davies 2009) and *H. brachysoma* (Φ'' = 4.990) (Prasad *et al.* 2012).

Mortality

The total mortality (*Z*), based on the length converted catch curve, of *M. cavasius* was 3.86 year^{-1} (Fig. 6). The estimated natural mortality (*M*) and fishing mortality (F), based on ambient temperature (28.5^{0}C), were 1.35 year^{-1} and 2.51 year^{-1} respectively. In the present study the total mortality (*Z*) *M. cavasius* was 3.86 year^{-1} which is less than the values reported for *H. membranaceus* (Ofori-Danson *et al.* 2001) and *H. brachysoma* (Prasad *et al.* 2012) and more than *S. intermidius* (Etim *et al.* 1999) and *C. laticeps* (Abowei and Davies 2009). The estimated fishing mortality (*F*) of *M. cavasius* in the present study was 2.51 year^{-1} which is less than the values reported for *H. brachysoma* (4.6 year^{-1}) (Prasad *et al.* 2012) and more than the valves reported for *S. intermidius* (Etim *et al.* 1999) and *C. laticeps* (Abowei and Davies 2009). The natural mortality (*M* = 1.35 year^{-1}) in the present study area was higher than the values reported for freshwater cat fishes reported elsewhere (Table 1). This could be due to the transportation of suspended silt and clay from upstream, due to open cast mining, during the onset of south west monsoon when fish migrate to upstream and water quality deteriorate (Shubharekha *et al.* 2018, Thippeswamy *et al.* 2020). During this period the fish were subjected to mass mortality due

to chocking of gills by suspended sediment and the dead fish were floating in the backwaters during the onset of monsoon period. The length cohort analysis revealed that the fishing mortality was in between 7.5 and 9.5. The peak value for mortality observed at length of 15.5 cm (Fig. 7). The exploitation rate (E) is an index used to assess if a stock is overfished, on the assumption that optimal value of E is equal to 0.5 yr^{-1} (Gulland 1965) and he further reported that when the exploitation rate is more than 0.5 yr^{-1}, the given stock is over fished. In the present study the exploitation rate was high (0.65 yr^{-1}) which indicated the over-fishing of *M. cavasius* at the study area.

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REFERENCES

Abowei JFN, Davies AO (2009) Some population parameters of *Clarotes laticeps* (Rupell 1829) from the freshwater reaches of Lower Nun River, Niger Delta, Nigeria. *Am J Sci Res* 2 : 10–19.

Bagenal TB (1955) The growth rate of the long rough dab *Hippo glassoides* platessoides (Fabr.). *J Mar Biol Ass* UK 34: 297-311. http://doi.org/10.1017/ S0025315400027673.

Bertalanffy von L (1938) A quantitative theory of organic growth (Inquiries on growth laws. II). *Human Biol* 10: 181-213.

Beverton RJH, Holt SJ (1957) On dynamics of the exploited fish populations. *Fish Invest Series* 11: 19 : 553.

Bhatt VS (1971) Studies on biology of some freshwater catfish, Part IV, *Mystus cavasius* (Ham). Hydrobiologia 38: 289-302. http://doi.org/10.1007/BF00036840.

Day F (1878) The fishes of India: Being a natural history of the fishes known to habitat the seas and freshwaters of India, Burma and Ceylon. William Dawson and Sons Ltd., London.

Etim L, Lebo PE, King PR (1999) The dynamics of an exploited population of *Siluroid catfish* (Schilbe intermidius, Repuell, 1932) in the Cross river, Nigeria. *Fish Res* 40: 295-307. http://doi.org/10.1016/S0165-7836(98)00217-3.

Fabens AJ (1965) Properties and fitting of the von Bertalanffy growth curve. *Growth* 29: 265-285.

Gayanilo Jr FC, Soriano P, Pauly D (1996) The FAO-ICLARM stock assessment tools (FiSAT) users' guide. FAO computerized information series (Fisheries), No. 8, FAO, Rome, pp 266.

Gulland JA (1965) Estimation of mortality rates. In: Cushing, PH (Ed). Key papers on fish populations. IRL Press Oxford, pp 231–241.

Gulland JA (1971) The fish resources of the Ocean West Polyfleet Survey. *FAO Tech Pap* 97 : 428..

Gupta S (2014) A review on *Mystus cavasius,* a popular food fish of Indian subcontinent. *Int J Fauna and Biol Stud (IJFBS)* 1: 27-31.

Hegde SN, Thippeswamy S, Acharya KK, Madhyastha NA (1992) The vertebrate fauna of the Mangalore region - A checklist. In: Perspective on Dakshina Kannada and Kodagu. Mangalore University, Mangalore, pp.297-346.

Jayaram KC (1977) Aid to identification of Siluroid fishes of India, Burma, Sri Lanka, Pakistan and Bangladesh. 1. Bagridae. Records of the Zoological Survey of India, Miscellaneous Publication, Occasional Paper 8, pp 1–41.

Muddanna V (1971) Freshwater fishes of Mysore state, their vernacular name, distribution, growth, breeding and fishery. Univ Agric Sci, Res Series No. 11, University of Agricultural Science, Bangalore, India.

Newman SJ (2002) Growth, age estimation and preliminary estimates of longevity and mortality in the perch *Lutjanus russelli* (Indian Ocean form), from continental shelf waters off north-western Australia. *Asian Fish Sci* 15: 283-294. http://doi.org/10.33997/j.afs.2002.15.3.009.

Ofori-Danson PK, Vanderpuye CJ, Graaf de GJ (2001) Growth and mortality of the catfish *Hemisynodontis membranaceus* (Geoffroy St. Hilaire), in the northern arm of Lake Volta, Ghana. *Fish Manag Ecol* 8: 37–45. http://doi.org/10.1046/j.1365-2400.2001.00214.x.

Oymak SA, Solak K, Unlu E (2001) Some biological characteristics of *Silurus triostegus* Heckel, 1943 from Ataturk Dam Lake (Turkey). *Turk J Zool* 25: 139-148.

Pantulu VR (1961) Determination of age and growth of *Mystus gulio* (Ham.) by the use of pectoral spine, with observations on its biology and fishery in Hooghly estuary. *Proc Nat Inst Sci India* 27: 198-216.

Pauly D (1980) On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J Cons Int Explor Mer* 39: 175–192. http://doi.org/10.1093/icesjms/39.2.175.

Pauly D (1983) Some simple methods for assessment of tropical fish stocks. FAO Fish Tech Pap 234, 52 pp.

Pauly D (1984) Fish population dynamics in tropical waters: A manual for use with programmable calculators. *ICLARM Stud Rev* 8: 325..

Pauly D, David N (1981) ELEFAN-I BASIC program for the objective extraction of growth parameters from length–frequency data. *Meeresforschung / Rep Mar Rea* 28: 205–211.

Pauly D, Munro JL (1984) Once more on the comparison of growth in fish and invertebrate. *Fishbyte* 2: 1-21.

Pauly D, Soriano-Bartz M, Moreau J, Jarre A (1992) A new model accounting for seasonal cessation of growth in fishes. *Aust J Mar Freshwater Res* 43: 1151-1156. http://doi.org/10.1071/MF9921151.

Penha JMF, Mateus LAF, Barbieri G (2004) Age and growth of the porthole shovelnose catfish (*Hemisorubim platyrhynchos*) in the Pantanal. *Braz J Biol* 64: 833-840.

Pethiyagoda R (1991) Freshwater fishes of Sri Lanka. The wildlife heritage trust of Sri Lanka, Colombo, pp 362.

Prasad G, Ali A, Harikrishnan M, Raghavan R (2012) Population dynamics of an endemic and threatened yellow catfish *Horabagrus brachysoma* (Günther) from Periyar River, south ern Western Ghats, India. J *Threatened Taxa (JOTT)* 4 :2333 –2342. http://doi.org/10.11609/JoTT.o2590.2333-42.

Rajagopal KV, Joseph MM, James PSRB (1978) A list of fishes of Karnataka. UAS Tech Ser No. 18, University of Agricultural Sciences, Bangalore, pp 50 .

Ramakrishnaiah M (1988) Age, growth and fishery of *Mystus aor* (Hamilton) from Nagarjunasagar reservoir. In: Mohan Joseph M (ed). The first Indian fisheries forum proceedings. Asian Fishery Society, Indian branch, Mangalore, pp 185-189.

Shubharekha B, Thippeswamy S, Raghavacharulu MV, Suresh GC (2018) Water quality of Bhadra River, a tributary of river Tungabhadra, in the central Western Ghats, India. In: Indira Gandhi – a visionary: Revisiting her policies and their impact, Proceedings of the international conference, Meera DB, Venissa M, Chandramohan M (eds), pp 155-165, St. Agnes College, Mangalore, India, 19 - 20 March, 2018.

Sparre P, Venema SC (1992) Introduction to tropical fish stock assessment, Part 1 Manual. *FAO Fish Tech Pap* 306 : 376 pp.

Thippeswamy S, Hegde SN (1999) Ichthyofaunal diversity of the Sharavathi tail race hydroelectric power project area in the Central Western Ghats of India. In: The Fourth Indian fisheries forum proceedings, Joseph MM, Menon MNR, Nair NU (eds). Asian Fisheries Society, Indian Branch, Mangalore, India, pp 53-56.

Thippeswamy S, Suresh CG, Raghavacharulu MV, Shubharekha B (2020) Spatial variability of water quality in the upstream Bhadra River, a tributary of river Tungabhadra, in the Western Ghats of Karnataka, India: Application of multivariate statistical techniques. *Ind J Geo Mar Sci* 49: 649-664.