



ISSN: 2347-5129

IJFAS 2014; 2(2): 249-255

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www.fisheriesjournal.com

Received: 05-09-2014

Accepted: 10-10-2014

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Effects of climate change on the occurrence of *Chitala chitala* (Hamilton-Buchanan, 1822) in Tripura

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Abstract

Chitala chitala (Hamilton-Buchanan, 1822) a near threatened fish species of freshwater ecosystem is considered as preferred fish to the consumers due to its taste. The occurrence and abundance of this species is greatly reducing in North-Eastern India. Thus, in view of conserving the species it is undoubtedly important to identify its environmental quality. The climatic characteristics of Tripura during last two decades showed that a little by little increase in temperature became a visible feature of the environment of Tripura. Simultaneously, a slow and gradual rise in humidity was also found to be evident. On the other, rainfall was decreased quantitatively. An inverse statistical correlation was noticed between air temperature and rainfall ($r = 0.99$, $P < 0.001$). Similar correlation was also observed between humidity and rainfall ($r = 0.99$, $P < 0.001$). However, a direct relationship was evident between air temperature and humidity. The physico-chemical characteristics of the freshwater river depicted a number of characteristics which were water temperature = 12.11-32.19 °C, water velocity = 1.66 - 4.02 m/sec, pH = 6.61-7.31, DO₂ = 4.44 - 6.89 ppm, HCO₃ = 112.14 - 152.76 ppm etc. Multivariate regression analysis showed that among diverse climatic parameters and environmental factors of freshwater river, some particular parameters viz., air temperature ($P < 0.001$), water temperature ($P < 0.001$), humidity ($P < 0.001$), rainfall ($P < 0.001$), water velocity ($P < 0.001$), depth of river ($P < 0.001$) and CO₂ ($P < 0.001$) have had significant control over the population occurrence of *Chitala chitala*.

Keywords: *Chitala chitala*, Threatened fish, River, Tripura,

1. Introduction

Chitala chitala (Hamilton-Buchanan, 1822) is a near threatened fish species ^[1, 2] (CAMP 1998, IUCN 2010). It inhabits in freshwater ecosystem under lotic water. This fish species was recorded from different countries such as India, Bangladesh, Pakistan, Myanmar, Nepal, Indonesia, Malaysia, Thailand and Cambodia as well ^[3]. As a preferential fish species it has greater demand to a large section of the consumers due to having special food taste in cooked condition. Geographically this species is distributed in India, Bangladesh, Borneo, Java, Sumatra, Laos, Sri Lanka, Nepal, Malaya, Myanmar, Pakistan, Thailand, Cambodia, and Vietnam ^[4, 5, 6, 7, 8, and 9]. The occurrence and abundance of this species is greatly reducing in different corners of the country. Although a remarkable occurrence was noticed in North-Eastern states of India at one time. Its drastically reduction during last two decades was evident ^[10, 11, 12].

Besides several factors climate changing feature may be considered one of the vital parameters responsible for degradation of freshwater environment. So, due to climate changing effect in freshwater environment it might affect the population of a freshwater ecosystem ^[13, 14, 15, 16, 17, 6, 18, 19, and 20]. Some workers ^[21, 22, 9, 23, 24, and 25] investigated the climate changing character in the freshwater environment of Tripura during last two decades. A number of effects in the freshwater environment of Tripura due to climate change was investigated and further, the subsequent effects on the faunal occurrence and abundance was also found out in many studies ^[10, 11, and 12]. Such an effect is the function of decline of diversity of freshwater fauna ^[26, 27, 28, and 29].

A look into the existing literature explicitly reveals that although some incomplete information on the biology of different endangered, vulnerable and rare fish species are available ^[30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51].

Limnological aspect of those fish species including *Chitala chitala* is not adequately recognized.

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As a result, in the limnological view point it is important to know *Chitala chitala* (Hamilton-Buchanan, 1822) under freshwater lotic environmental condition. For this reason, the present paper communicates the present status of climate change in Tripura and its effects on the occurrence of *Chitala chitala* (Hamilton-Buchanan, 1822).

2. Materials and methods

For the present studies the wild samples of *Chitala chitala* (Hamilton-Buchanan, 1822) was collected from Muhuri river (Latitude 23°13.826' 33" N, Longitude 91°33.598' 03" E), South district of Tripura [figs. 1(a), 1(b) and 2]. The fish was sampled with drag netting during early morning period. During the study period killing of the live specimen was avoided. So, after observations the fish samples were returned

to the river water immediately. The water sample was collected from the sub-surface layer of the river water during early morning period. For the purpose of investigation different freshwater environmental parameters such as water temperature, turbidity, water velocity, CO₂, pH, DO₂, HCO₃, salinity, silicate, dissolved organic matter, NO₃ N and PO₄ P etc were analyzed. For estimating the concentrations of CO₂, HCO₃, DO₂, Salinity, NO₃ N and PO₄ P, a standard methodology was followed [52]. For analyzing the other parameters the methodology of a standard literature was adopted [53]. A multivariate statistical regression was done using SPSS version software for study of the nature of correlation of different climatic parameters as well as physico-chemical quality of river water with regard to the population density of *Chitala chitala*.



Fig 1(a): Sampling Site (blue coloured) at Muhuri River area of Tripura



Fig 1(b): Collection of fish samples from Muhuri river of Tripura.



Fig 2: Collection of *Chitala chitala* from Muhuri river of Tripura.

3. Results and discussion

The climatic features of the studied river area were presented in Table 1 and Figs. 3-7. The results of the physico-chemical characters of Muhuri river water were presented in table 2. The results of multivariate regression analysis of various climatic

characters as well as different environmental parameters of freshwater river water in relation to the population density of *Chitala chitala* were stated in Table 3.

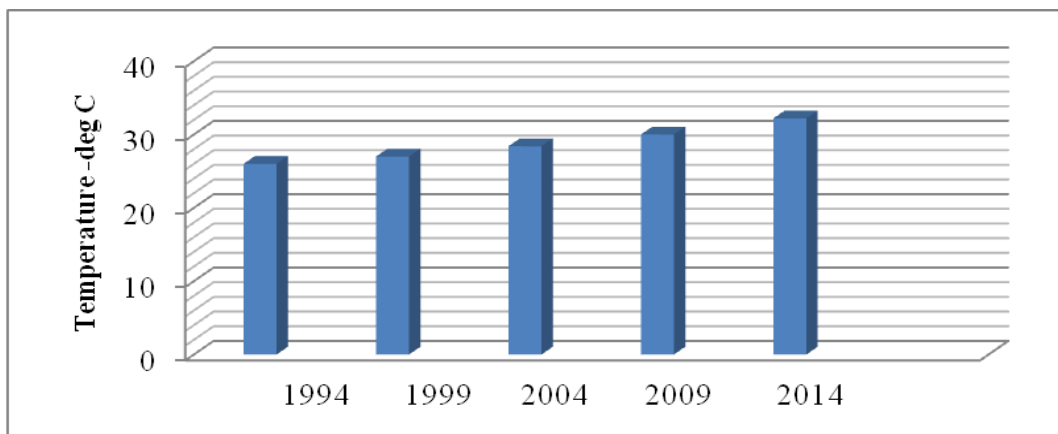


Fig 3: Studies of temperature (maximum) during twenty years in Tripura.

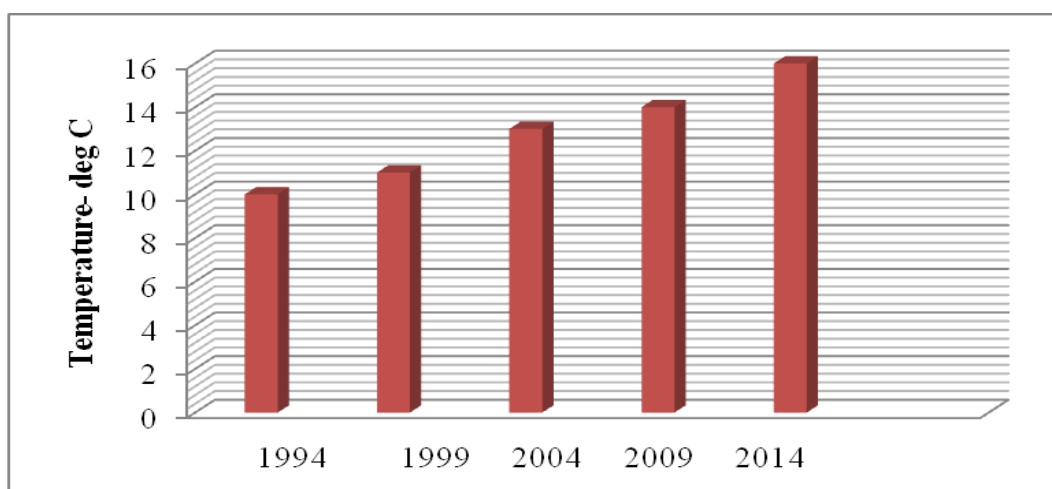


Fig 4: Studies of temperature (minimum) during twenty years in Tripura.

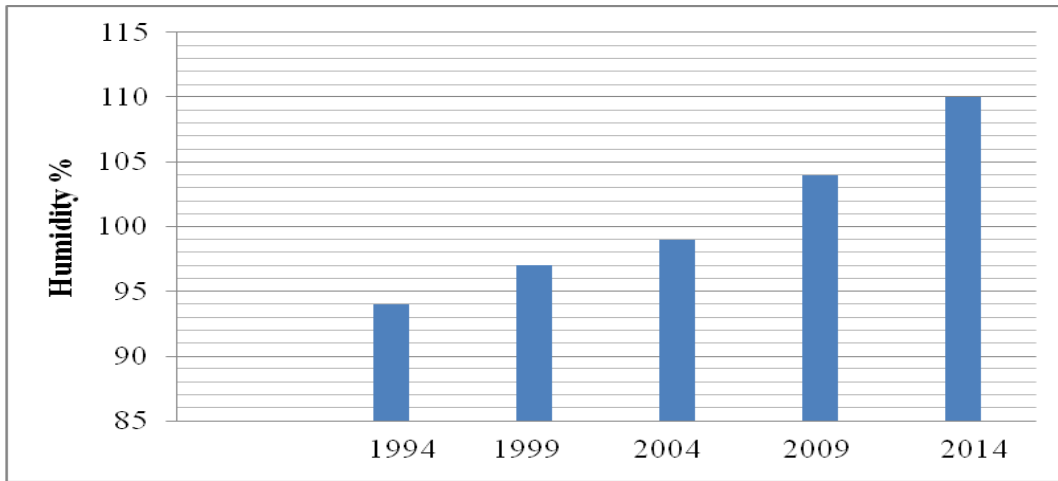


Fig 5: Studies of humidity (maximum) during twenty years in Tripura.

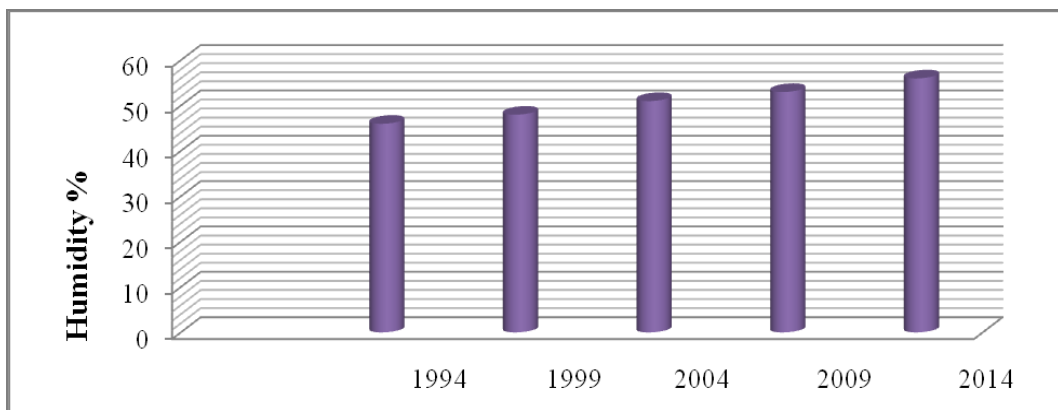


Fig 6: Studies of humidity (minimum) during twenty years in Tripura.

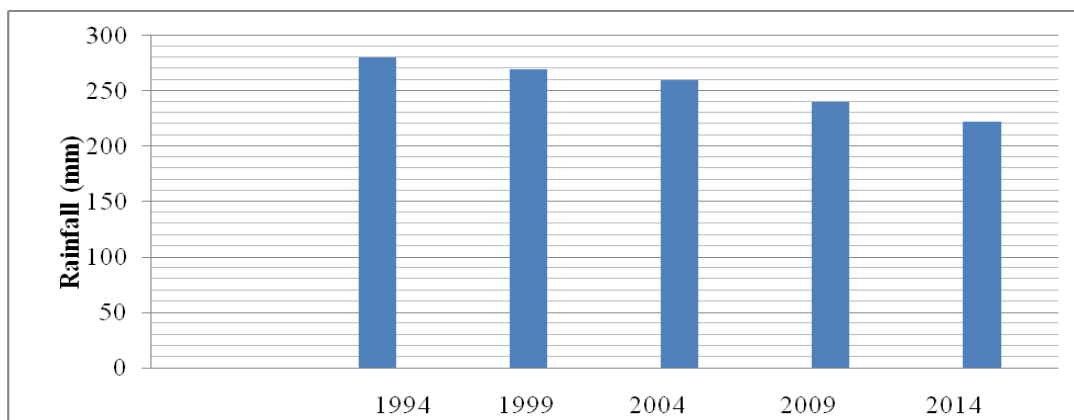


Fig 7: Studies of rainfall during twenty years in Tripura.

Table 1: Climatic characters in the area of Muhuri River during 1994-2014.

Sl. No.	Parameter	Range and mean	
1.	Air temperature (maximum)	25.86-32.19	28.82 °C
2.	Air temperature (minimum)	9.81-15.66	12.64 °C
3.	Humidity (maximum)	93.98 – 109.94	110.02%
4.	Humidity (minimum)	45.66-55.86	51.44%
5.	Rainfall	222.08 – 279.65	261.12 mm
6.	Dissolved free CO ₂	3.86 – 16.84	12.22 ppm

Table 2: Environmental feature of Muhuri River during 2012-2014.

Sl. No.	Parameter	Range and mean	
1.	Water temperature	12.11-32.19	23.11°C
2.	Water velocity	1.66 - 4.02	3.12 m/sec
3.	Turbidity	24.22 – 52.72	34.12 cm
4.	pH	6.61-7.31	7.14
5.	Dissolved Oxygen	4.44 – 6.89	4.88 ppm
6.	HCO ₃	112.14 – 152.76	132.28 ppm
7.	Dissolved organic matter	12.74 – 28.98	18.64 ppm
8.	Salinity	0.0001 – 0.01	0.003 ppt
9.	Silicate	6.56 – 11.24	8.16 ppm
10.	PO ₄ P	0.006 - 0.01	0.008 ppm
11.	NO ₃ N	0.004 - 0.01	0.007 ppm

The climatic characters for a period of two decades exhibited that the air temperature was escalating slow and gradually (figs. 3-4) [65, 66, 67] and also the humidity was enhancing similarly (figs. 5-6). However, the amount of rainfall was found to be continuously decreased (fig. 7).

Statistical data showed an inverse relationship between the parameters of air temperature and rainfall ($r = 0.99$, $P < 0.001$).

Simultaneously, an inverse correlation was also recorded between two important climatic parameters such as humidity and rainfall ($r = 0.9866$, $P < 0.001$). Some workers [21, 23, 24, 25] pointed out that certain climatic characteristic of Tripura was found to be increasing little by little over a period of two decades.

Table 3: Multivariate regression analysis of some climatic and environmental factors of river water over the population density of *Chitala chitala*

Variables	Reg. Coeff.	±S.E.	F	Beta coefficient
Air temperature	31.98	0.94	28.96	0.87*
Water temperature	524.04	0.96	28.04	6.37*
Rainfall	19.53	0.18	21.78	0.85*
River depth	1.07	0.35	19.41	0.66*
Water velocity	16.51	0.32	19.93	0.66*
CO ₂	1.93	0.18	21.85	0.88*

Multiple correlation coefficient (R) = 0.88345

Coefficient of multiple determination (R^2) = 0.78048

Analysis of variance table

Source	Degree of freedom	Mean sq.	F	Conf. level
Regression	6	67036.25	19.95	99.968*
Residual	29	6733.89		
Total	35			

* $P < 0.001$

So, those climatic characters might be responsible for causing gradual warming condition in the environment and so, this condition might also be responsible for suppressing the fish diversity in the freshwater ecosystem of Tripura either directly or indirectly. Some workers [23, 24] argued that such a rise in temperature and fall in rainfall in the environment will develop a suppressing condition in the fish breeding physiology. As a result, throughout monsoon phase the fish breeding performance will largely be affected. Thus, it will suppress fertilization in the fishes which will ultimately lead to block the onward fish progeny [54, 55, 56].

Several workers [57, 58, 56, 59] pin pointed that the rainfall acts as vital climate stimulant for maturation of gonad in both female and male fish. They [57, 58, 56, 59] further pointed out that the rainfall greatly stimulates the release of 11-alpha-keto testosterone for maturation of spermatozoa in male and of beta-oestradiol for maturation of ova in female.

Multivariate regression analysis (table 3) also indicated that certain physical parameters of freshwater such as water velocity, depth of water body, etc features and some climatic factors such as air temperature, humidity, rainfall etc. were found to be significant. Since the studied fish was a lotic

species so, it may be presumed that water velocity playing important role in the maturation of gonad of *Chitala chitala*. Further, this fish species requires a high depth water body for food search which might be affected due to decline of depth gradually. Therefore, a decline in speed of water velocity and depth of river water will have an adverse affect over life of freshwater lotic fauna [54, 55, 56]. Several researchers [60, 36, 61, 62, 63, 64] noticed that for accelerating the survival rate and growth potential of the fishes it is very essential for maintaining suitable limnological conditions in the habitat so that an effective metabolic activities will be restored in the life history parameters of a fish species [65, 66, 67]. Hence, it is prerequisite to conserve *Chitala chitala* in the lotic freshwater ecosystem.

4. Conclusion

Certain climatic characters such as temperature, humidity, etc. may be considered effective which stimulate the gradual warming in the environment. Presumably for this reason, rainfall decreasing quantitatively. Therefore, low amount of rainfall affecting fish breeding performance. Thus it is suppressing the rate of fertilization in the fishes. Ultimately, quantitative production of onward fish progeny is greatly

affected.

Therefore, temperature and humidity either directly or indirectly suppressing the fish diversity in freshwater ecosystem of North-Eastern Indian in general and Tripura in particular.

5. Acknowledgements

One of the authors (SB) is grateful to the DST (Sanction no. SR/SO/AS/-016/2013, dated: 27/11/2013) for financial support. Thanks are due to Head, Department of Zoology, Tripura University (Central University) for the facilities provided. Cooperation extended by Sri Kshitish Chandra Das, progressive fish farmer at Udaipur, Gomoti district, Tripura is thankfully acknowledged.

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