""STUDIES ON PHYSIOCHEMICAL PARAMETER ANALYSIS DURING SEASONALITY AND DIVERSITY, DISTRIBUTION STATUS OF FRESHWATER STREAMS FISHES IN PALANI HILLS OF SOUTHERN INDIA"

Mr.S.KALAIMANI[1], Dr.C.KANDEEPAN[2]

1. Research Scholar, PG and Research Department of zoology, A.P.A college of Arts and Culture, palani-624601, Dindigul (D.t), Tamil Nadu, India.

2. Assistant professor of zoology, Head, PG and Research Department of zoology, A.P.A college of Arts and Culture, palani-624601, Dindigul (D.t), Tamil Nadu, India.

ABSTRACT:

Western Ghats, India is a renowned UNESCO World Heritage Site and is one of the 'hotspots' of biological diversity, popularly known as "Great Escarpment of India". Western Ghats is well known for the rich freshwater fish fauna with a high level of endemism. However, a major part of the faunal diversity of Western Ghats is threatened by human intervention and invasive species during pandemic situation. Hence, knowledge of the diversity and distribution of the fresh water stream fish fauna is essential for designing and implementing conservation strategies. In the present study, small hill streams located within the Latitudinal range of 10.10 N – 10.44 N, Longitudinal range of 77.23 E to 77.68 E within the altitudinal range of 250m – 205 m Mean Level Sea Level (MSL) that flows southeast and Southwest directions covering about 90.5 sq km area from origin were studies physiochemical parameters during and after pandemic situation it affect distributional pattern of freshwater stream fishes in palani hills.

KEY WORDS: Stream fishes, Physical parameter, Chemical parameters, Fish biology, streams of Palani hills,

INTRODUCTION

Western Ghats of South India is a renowned UNESCO world Heritage site and is one of the 'Hotspots" of biological diversity, popularly known as "Great Escarpment of India "Western Ghats of South India is well known for the rich freshwater fish fauna with a high level of endemism. However a major part of the sauna diversity of Western Ghats is threatened by human intervention and invasive fish species. The knowledge of the diversity and distribution of the fish sauna is essential for designing and implementation conservation strategies. In the present day of study small palani hills streams located within the latitudinal range of 10.10N – 10.44 N, longitudinal range of 77.3 E to .68 E within the altitudinal range of 250m – 2050m mean sea level (MSL) that flows Southeast and South West direction covering about 90.55 km area from origin were studies in Palani hills.

Small Palani hills streams generally have rough, rocky, boulder and pebbled substratum which affect the occurrence, distribution and productivity of fish sauna. All the fresh water resources of the Palani hills region. Compounds a very rich and colorful ichthys fauna, drift species of fishes have been abundantly habited in drift. Streams in the study area. Fish distribution and abundance from different parts of Western Ghats have been evaluated by different authors. Detail account of freshwater fishes has been provided by Day. Further, investigations on the freshwater fish fauna of Western Ghats were initiated by Hora) and Hora and Law. Silas listed 25 fish species from the Anamalai Hills and 10 species from the Nelliampathi Hills. Arunachalam and manimekalan reported economically important and cultivable fishes of the Nirgiri biosphere reserve later he described the assemblage structure of stream fishes in the Western Ghats. Meanwhile, Manimekalan and Das described a new species, Glyptothorax davissinghi (Pisces: Sisoridae), a new catfish from Nilambur, Nirgiri Biosphere. Manimekalan and Singh recorded Schismatorhynchus (Nukta (nukta (Sykes) (Pisces: Cyprinidae) from Moyar River. Later, Arunachalam et al., reported the occurrence of Neolissochilus wynaadensis, from Karnataka. Earlier, Biju et al., recorded Puntius filamentosus and Puntius melanampyx (Day) in Orukomban and Thelikal respectively. Manimekalan and Arunachalam (2002) rediscovered the critically endangered air – breathing catfish Clarias dayi Hora (Pisces: Claridae) in Mudumalai Wildlife Sanctuary. Johnson and Arunachalam reported the diversity, distribution and assemblage structure of fishes in streams of southern Western Ghats. Knight et al., described a new species of barb Puntius nigripinnis (Teleostei: Cyprinidae (from southern Western Ghats. Rema Devi and Menon described Horalabiosa palaniensis, Cyprinid fish from Palani Hills, Western Ghats. Recently, Arunkumar et.al., reported nearly 37 species in the Cauvery River System. Meanwhile, Mogalekar of Tamil Nadu with the growing international trade of ornamental fishes, some of the fishes like Puntius denisonil, Tetraodon travancoricus, Horabagrus nigricullaris and several species of the genus Punitius, Danio, Garra, Loaches, Bagrids and Cichlids are in great demand in domestic as well as international market as aquarium fish. These fishes are being collected from natural habitats and exported resulting into drastic in their natural population. Several studies have indicated that breeding of Nemacheilus species Puntius denisonii is warranted as over exploitation of wild stock of these fishes could be the main reason for their diminution in the wild. However, the primary constraint with the endemic ornamental fish species is the loss of natural bright colour under captivity. Therefore, few of the endemic ornamental species have been identified for captive breeding and aquaculture Puntius denisonii and Danio malabaricus, along with other species like P. Fasciatus, P. melanostigma, P. filamentosus, P. arulius, Tetraodon travancoricus, Chela dadyburjori, Horabagrus brachysoma, H.nigricollaris and Nemacheilus as over-exploitation of wild stock of these highly-priced fishes can lead to their extinction.It has been now well established that fish diversity is determined by the geographical location, ecological condition and physiochemical nature of the aquatic habitat. Freshwater fishes, for example, may be the

most threatened group of vertebrates on earth after amphibians and the global extinction rate of fishes is believed to be in excess of higher vertebrates (Bruton, 1995) However, conservatory measures to mitigate the impact of the pressures have not only been slow but also inadequate and as a result many of the aquatic species are declining rapidly. The main causes behind the loss of biodiversity in freshwater are habitat degradation and fragmentation, exotic species introduction, water diversions, pollution and global climate impacts (Gibbs, 2000). The Indian subcontinent, occupying a position at the confluence of three biogeography realms, viz., the Palaeartic, Afro-Tropical and Indo-Malayan, exhibits a great variety of ecological habitats, harboring rich ichthyofaunal diversity, comprising about 2500 species of which 930 species are freshwater inhabitants and 1570 are marine. The Indian species represent about 8.9% of the known fish species of the world. Jayaram (2010) listed 852 freshwater species of fishes under 272 genera, 71 families and 16 orders, including both primary and secondary freshwater fishes from India, Bangladesh, Myanmar, Nepal, Pakistan and Sri Lanka. Freshwater fishes are a poorly studied group since information regarding distribution, population dynamics and threats is incomplete, and most of the information available is from a few well-studied locations only (Sabuj Kumar chaudhuri 2010).Conservation and management of biodiversity relies on effectively monitoring rare (or) patchily distributes species across large area (Bogich et al., 2008).

OBJECTIVES

1. To inventoried Physiochemical parameters of Freshwater streams during Seasonality wise in Palani hills
2. To assess the Diversity, Distributional status of Freshwater stream fishes in Palani hills.

MATERIALS AND METHODS

ECOLOGICAL STUDY OF COLLECTION AREA:

In total of 11 sites (5 Low, 5 Mid and 2 High Elevations) will be selected from Palani hills. In each site, three replicas will be made between 1 m intervals. Month-wise sampling will be carried out for a year. The Physico-chemical parameters of sampling site will be measured by following: Latitude, Longitude and elevation of sampling sites will be taken from GPS (Global Positioning System); temperature, pH, dissolved oxygen, velocity depth, substrates, etc will be measured. The fish surveys and identification will be carried out through non-destructive sampling by using sampling methods suited to the nature of river course, stream order, flow, presence of aquatic vegetation and local human disturbance. Visual surveys, cast nets, gill-nets and hooks and lines were used to sample fish species. Fish species will be identified with the aid of taxonomic keys and field guides (Jayaram 1981, 2010). Information on threats to and ecology of species will also be collected based on observation, measurements of stream

related ecological covariates and semi structured interviews with local key informants. The collected fishes will be preserved separately in the field using 99% ethanol.

COLLECTION OF SAMPLING:

Freshwater Samples Collection streams in Palani Hills of South India arranged based on Elevation.

S.NO	Low elevation (m)	S.NO	Mid elevation (m)	S.NO	High elevation (m)
1.	Poolathur(900)	**6.**	Adukkam(1406)	**10.**	Samakadu(1538)
2.	Kumbakarai(400)	**7.**	Silver cascade(1256)	**11.**	Pillar rock(1534)
3.	Pachalur(296)	**8.**	Kurusedi(1213)		
4.	Rat tail falls(290)	**9.**	Moolayar(1186)		
5.	Thallakuttu falls(250)				

RESULT AND DISCUSSION

The fish fauna were surveyed from the streams and rivers of the Southern Western Ghats during one year period of seasonality wise analysis. The collection sites were selected based on the earlier fish faunal distribution in literature. Western Ghats is a mountain range that runs almost parallel to the Western Ghats of the Indian peninsula well known for its splendid biodiversity both in terms of richness and endemism. The physical and chemical climatic records of the selected study sites (Adukkam, Bear Shola falls, Fairy falls, Guntar, , Kumbakarai, Kurusedi, Moolayar, Pachalur, Pillar Rock, Poolathur, Rattail falls, Samakadu, Silver cascade and Thalakuttu falls) was given in (Table:1) .The chemical parameters recorded from the study sites different collection sites wise Sample 1,2 and 3 (Table.1a),. The chemical parameters were collected their Salinity, TDS, PH, EC valves, DO_2. Maximum water temperature (24.1^0C) was recorded at Pillar rock and a minimum water temperature (13.4^0C) was noted at Poolathur. Characteristic features of small streams such as stream width, water depth, current velocity and the percentage canopy cover, bedrock, boulder, pebbles, and sand in the study sites are provided in large scale studies performed in other areas, geomorphologic ally variables such as climate and altitude have been considered as the major factors responsible for macro-invertebrate distribution. Results indicate that large scale variables were responsible for determining the diversity of fresh water stream fish communities. Multivariate analysis suggests that physical and chemical variables significantly influence the distribution and abundance of fresh water stream fishes in streams of palani hills of Southern Western Ghats. Apart from these variables, elevation was an important factor. Identified some fish species in that collection area of palani hills and collect fish identification and fish morphological studies, feeding habit, biology studies ,distribution,IUCN status, threat to human and its uses was tabulated (Table:3).

Table: 1. PHYSICAL PARAMETERS OF THE SAMPLING SITES: PRE MONSOON SEASON

Area of collection	Latitude (N)	Longitude (E)	Elevation (m)	Temperature		Stream width (m)	Water depth (cm)	Current velocity (sec/m)	Canopy cover (%)	Local human distribution
				At	Water					
1.Poolathur	10.16152	77.321	900	17.2	13.4	2	11	0.09	90	YES
2.Kumbakarai	10.17739	77.535	400	17.2	14.8	8	7	10.7	80	YES
3.Pachalur	10.39085	77.667	296	17.3	15.2	4	5	2.1	80	YES
4.Rat tail falls	10.13133	77.373	290	22.7	16.5	9	5	0.08	60	YES
5.Thallakuttu falls	10.44181	77.686	250	19.7	16.7	5.5	40	0.09	50	YES
6.Adukkam	10.23677	77.543	1406	23.5	18.4	14	3.5	3.9	10	NO
7.Silver cascade	10.24537	77.516	1256	22.1	19.7	3	10	0.03	80	NO
8.Kurusedi	10.27633	77.559	1213	22.3	20.1	2	5	50.9	80	YES
9.Moolayar	10.26903	77.611	1186	22.4	20.1	5	6	10.05	50	YES
10.Samakadu	10.24044	77.564	1538	26.7	23.2	2	3	3.2	20	YES
11.Pillar rock	10.21018	77.466	1534	26.0	24.1	2	5	2.1	50	NO

TABLE: 1A.CHEMICAL PARAMETER OF THE SAMPLING SITES: PRE MONSOON SEASOON

Area of Collection of sample	SALINITY (ppm)			Total Dissolved Solids (ppm)			PH (Acid base valve)			EC (Electrical Conductivity) (µsec)			DO_2 (mgL^{-1})		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
1.Poolathur	42.2	42.4	42	48.5	48.2	48.4	7.1	7.2	7.4	55.3	55.1	54.9	8.2	8.1	8.5
2.Kumbakarai	43.1	43.4	42.9	90.3	90.4	90.1	7.6	7.7	7.5	75.1	75.4	75.5	8.1	8.4	8.6
3.Pachalur	63.2	63.4	63.5	95.2	95.1	95	6.8	6.7	6.5	122.3	122.4	122.1	10.2	10.4	10.1
4.Rat tail falls	48.8	48.2	48.7	67.2	67.3	67	7.4	7.2	7.1	82.4	82.1	82.3	7.5	7.4	7.3
5.Thallakuttu falls	75.2	75.1	75	126.4	126.3	126	6.7	6.3	6.5	432.2	432.4	432.5	9.3	9.4	9.1
6.Adukkam	13.6	13.2	13.5	20.6	20.5	20.4	6.7	6.8	6.9	129.1	129.4	129.2	13.5	13.2	13.4
7.Silver cascade	12.1	12.4	12.3	18.4	18.2	18.1	6.3	6.2	6.4	26.4	26.5	26.6	6.3	6.5	6.1
8.Kurusedi	28.7	28.5	28.6	17.5	17.6	17.4	6.3	6.4	6.5	44.7	44.5	44.6	5.6	5.2	5.3
9.Moolayar	91.6	91.4	91.5	67.2	67.4	67.1	7.2	7.3	7.1	63.9	63.8	63.6	7.4	7.3	7.5
10.Samakadu	15.7	15.4	15.6	13.6	13.5	13.7	7.1	7.4	7.2	18.9	18.6	18.7	7.3	7.1	7.5
11.Pillar rock	17.5	17.3	17.1	21.1	20	20.2	6.2	6.3	6.1	30.5	30.3	30.1	6.9	7.1	6.8

Table: 2. PHYSICAL PARAMETERS OF THE SAMPLING SITES: MONSOON SEASON

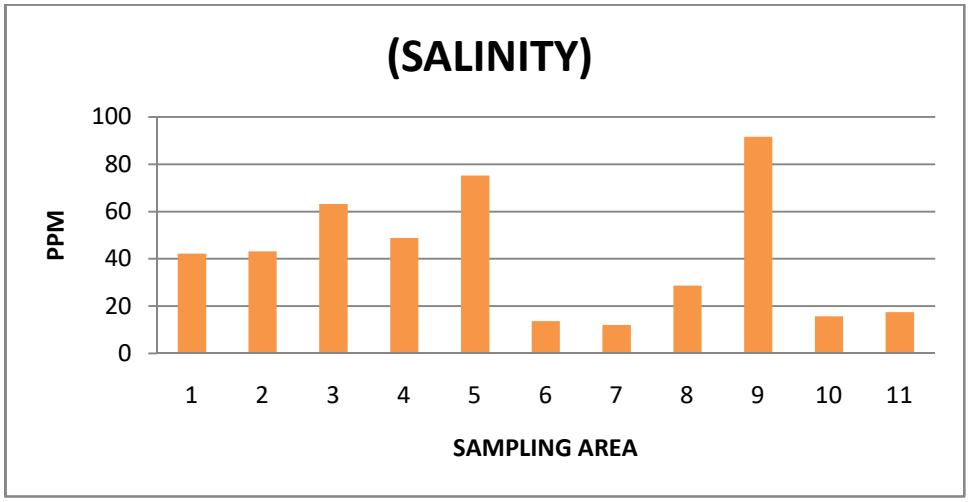
Area of Collection	Latitude (N)	Longitude (E)	Elevation (m)	Temperature		Stream width (m)	Water depth (cm)	Current velocity (sec/m)	Canopy cover (%)	Local human distribution
				At	Water					
1.Poolathur	10.16152	77.321	900	18.2	12.4	2	10	0.08	80	YES
2.Kumbakarai	10.17739	77.535	400	17.4	13.8	7	6	10.6	70	YES
3.Pachalur	10.39085	77.667	296	17.2	14.2	3	4	2.2	70	YES
4.Rat tail falls	10.13133	77.373	290	21.7	15.5	8	6	0.07	50	YES
5.Thallakuttu falls	10.44181	77.686	250	18.7	15.7	5.4	41	0.08	40	YES
6.Adukkam	10.23677	77.543	1406	23.4	17.4	14	2.5	3.8	11	NO
7.Silver cascade	10.24537	77.516	1256	22.2	18.7	2	9	0.02	70	NO
8.Kurusedi	10.27633	77.559	1213	22.2	21.1	3	4	50.8	70	YES
9.Moolayar	10.26903	77.611	1186	22.3	19.1	4	5	10.06	60	YES
10.Samakadu	10.24044	77.564	1538	25.7	22.2	3	4	3.3	30	YES
11.Pillar rock	10.21018	77.466	1534	25.0	23.1	3	4	2.2	60	NO

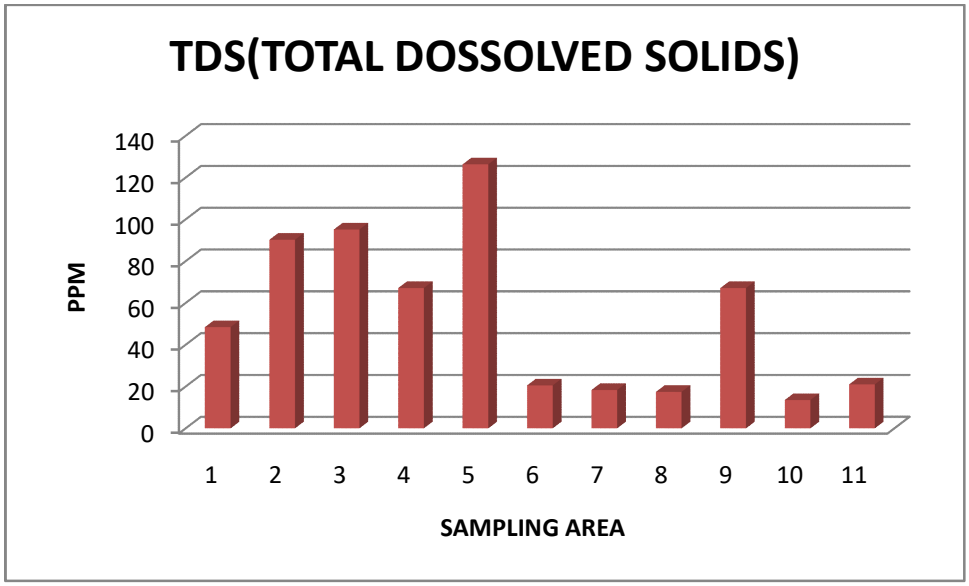
TABLE: 2 A. CHEMICAL PARAMETER OF THE SAMPLING SITES: MONSOON SEASOON

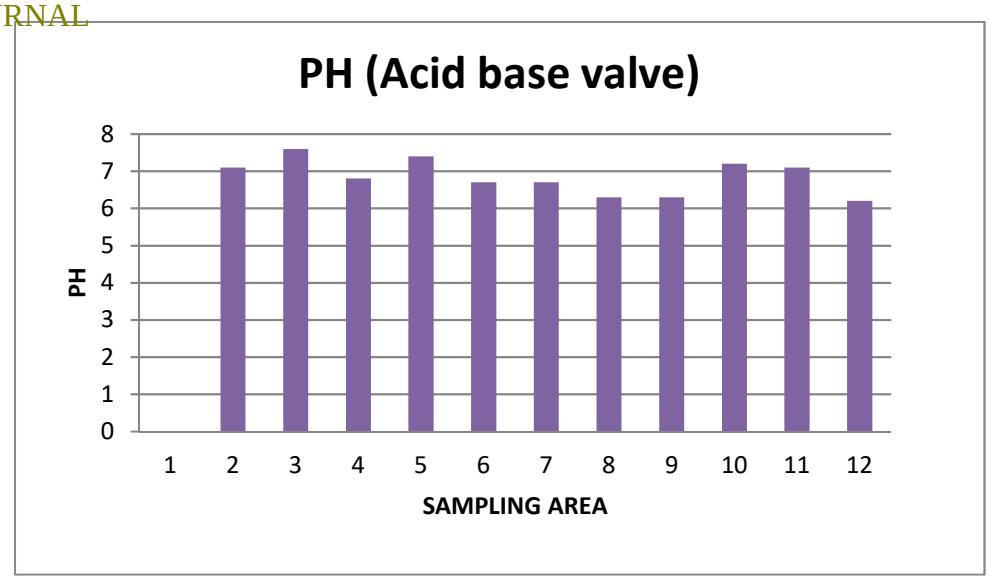
Area of Collection of sample	SALINITY (ppm)			Total Dissolved Solids (ppm)			PH (Acid base valve)			EC (Electrical Conductivity) (µsec)			DO_2 (mgL^{-1})		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
1.Poolathur	43.2	42.9	43.1	44.5	44.3	44.5	7.4	7.3	7.2	56.3	56.1	56.2	8.3	8.4	8.1
2.Kumbakarai	43.1	43.2	42.9	92.3	92.1	91.9	7.6	7.5	7.3	75.1	75.3	75	8.1	8.3	7.9
3.Pachalur	62.2	62.1	62.4	94.2	94.5	94.4	6.5	6.9	6.3	132.3	131.9	132.4	11.2	11.3	11.1
4.Rat tail falls	48.8	48.7	48.6	62.2	62.4	62.5	7.4	7.1	7.2	81.4	80.4	81.3	7.5	7.4	7.1
5.Thallakuttu falls	74.2	74.1	74.3	116.4	116.1	116.2	6.4	6.2	6.1	422.2	422.1	422	8.3	8.2	8.3
6.Adukkam	12.6	12.4	12.5	20.6	20.5	20.3	6.7	6.6	6.9	127.3	127.2	127	15.5	15.3	15.1
7.Silver cascade	12.2	12.4	12.1	14.4	14.3	14.2	6.3	6.4	6.5	25.4	25.3	25.1	6.3	6.2	6.4
8.Kurusedi	27.7	27.6	27.9	17.5	17.4	17.2	6.4	6.1	5.9	46.7	46.3	46.5	6.6	6.8	6.9
9.Moolayar	91.6	91.5	91.3	66.2	66.3	66	7.4	7.2	7.1	62.9	63.1	63.2	7.4	7.8	7.7
10.Samakadu	16.7	16.5	16.4	14.6	14.2	16.4	7.3	7.2	6.9	19.9	19.7	19.8	7.5	7.6	7.7
11.Pillar rock	18.5	18.4	18.3	24.1	24.3	24	6.3	6.9	7.1	31.5	31.8	31.6	7.9	8.1	8.2

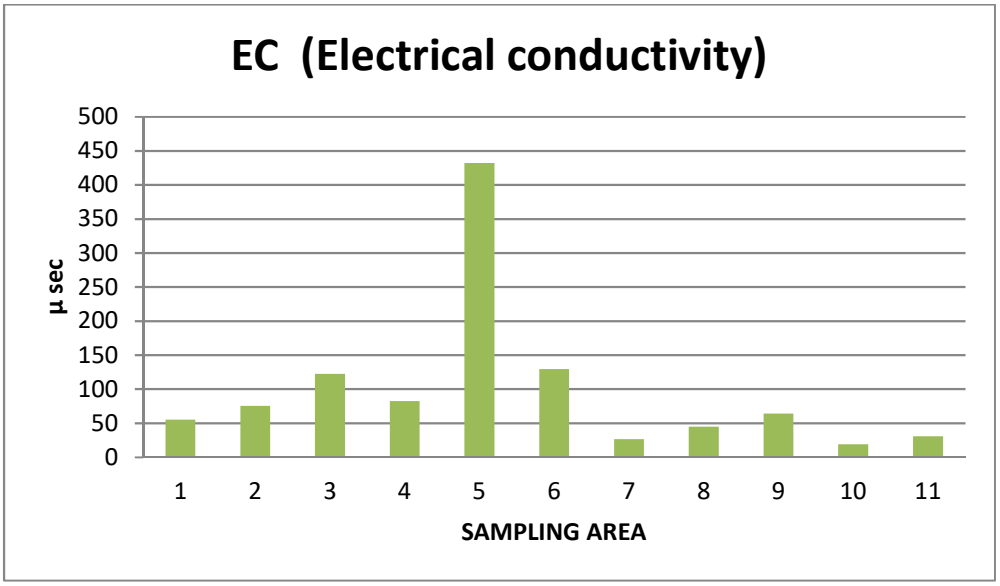
GRAPH: 1.GRAPHICAL PRESENTATION OF CHEMICAL PARAMETER

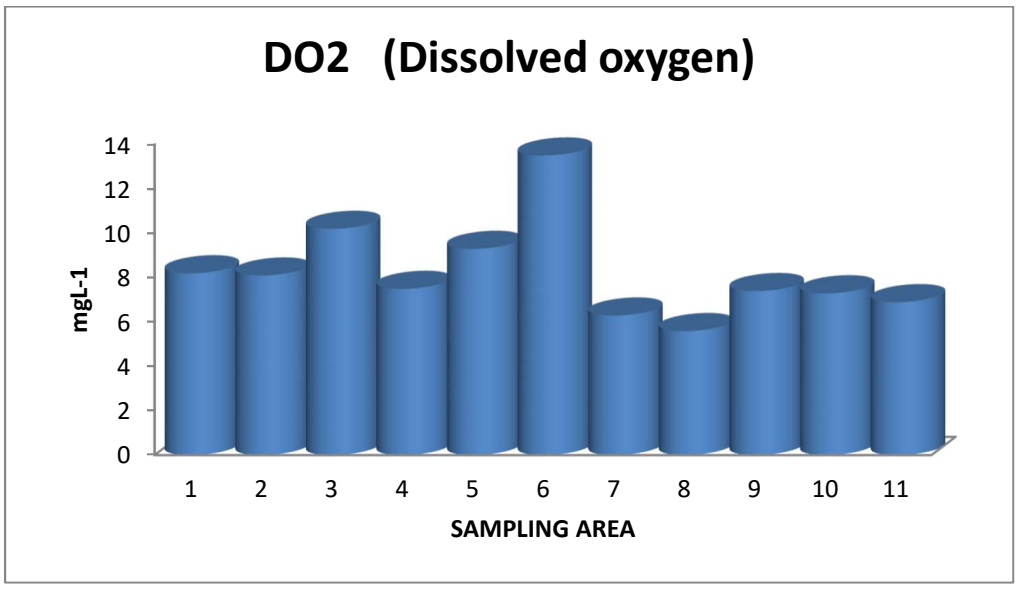
SAMPLE:1





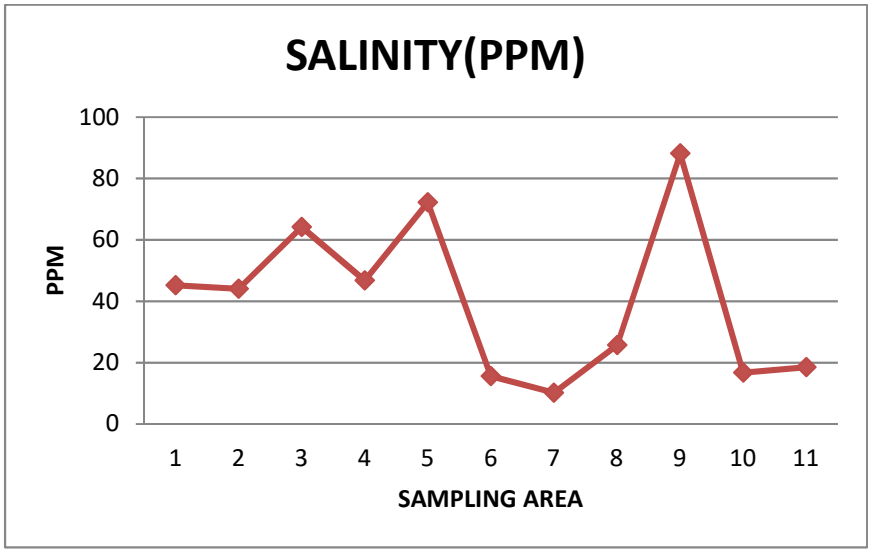

PH (Acid base valve)
PH
0
1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8
9
10
11
12
SAMPLING AREA

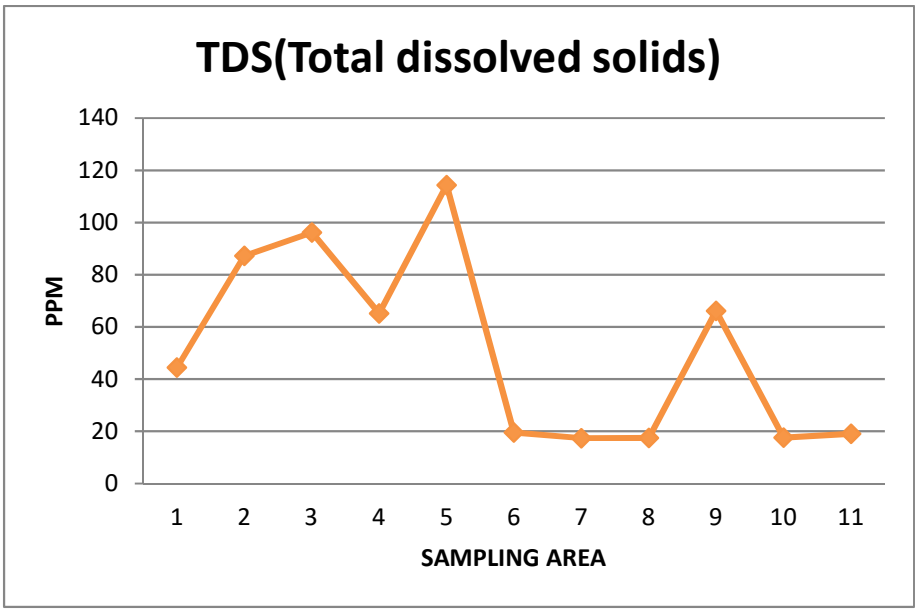

EC (Electrical conductivity)
µ sec
0
50
100
150
200
250
300
350
400
450
500
1
2
3
4
5
6
7
8
9
10
11
SAMPLING AREA

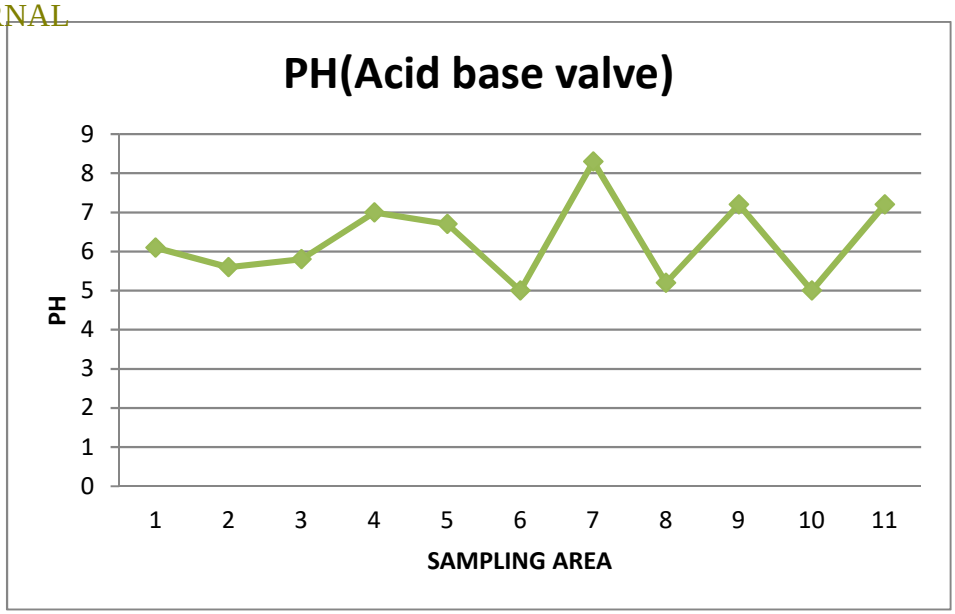

DO2 (Dissolved oxygen)
mgL-1
0
2
4
6
8
10
12
14
1
2
3
4
5
6
7
8
9
10
11
SAMPLING AREA

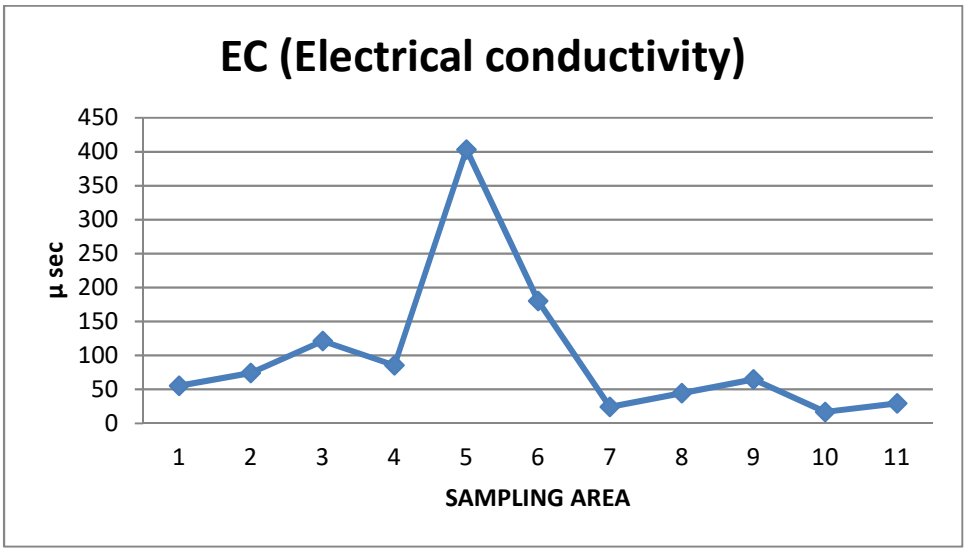
GRAPH: 2.GRAPHICAL PRESENTATION OF CHEMICAL PARAMETER

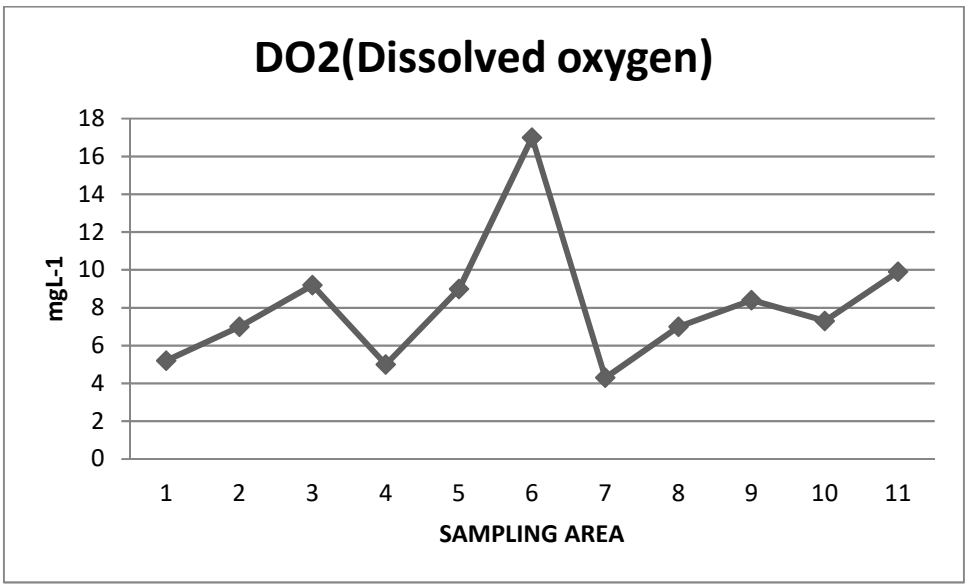
SAMPLE: 2





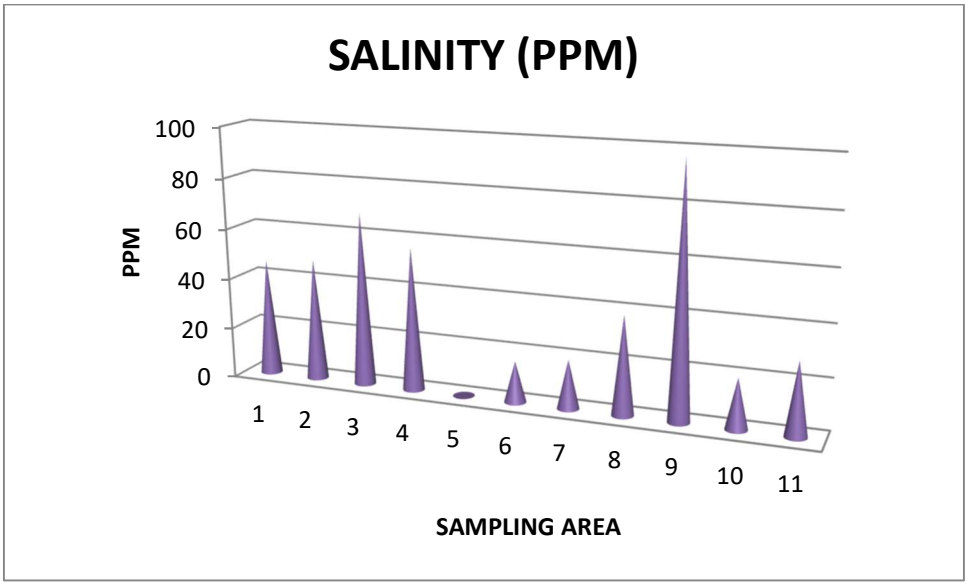

PH(Acid base valve)
PH
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
10
11
SAMPLING AREA

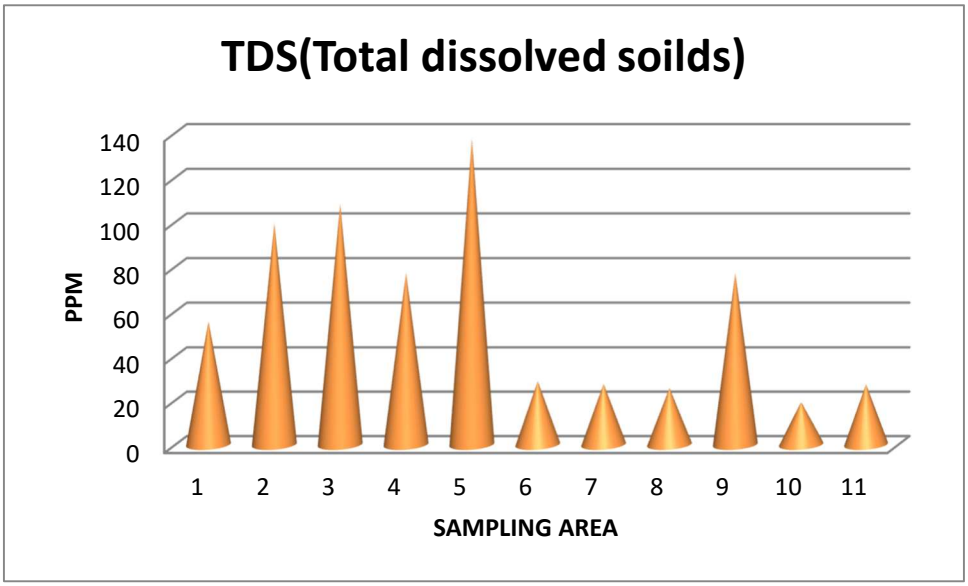

EC (Electrical conductivity)
µ sec
0
50
100
150
200
250
300
350
400
450
1
2
3
4
5
6
7
8
9
10
11
SAMPLING AREA

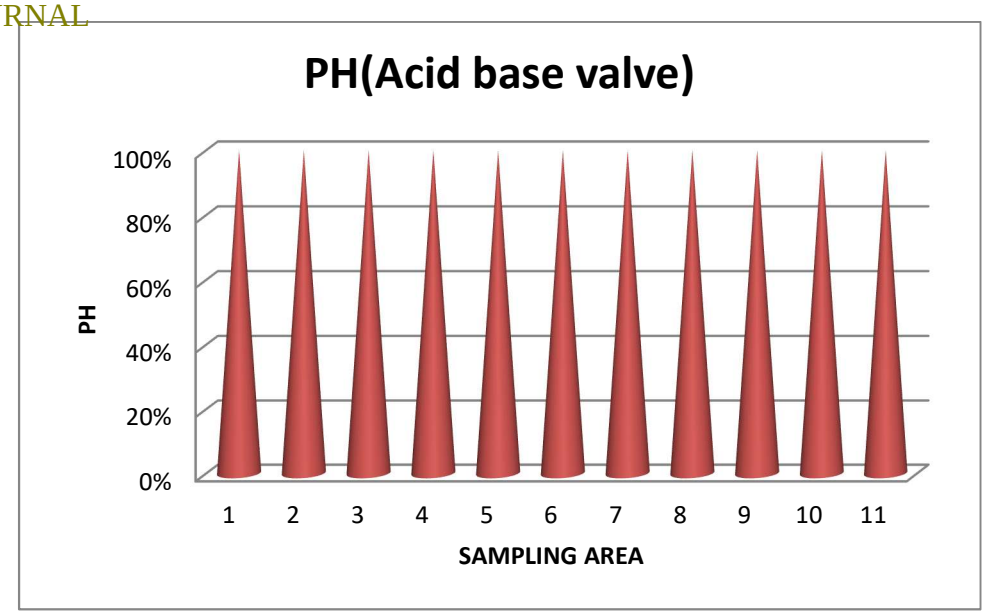

DO2(Dissolved oxygen)
mgL-1
0
2
4
6
8
10
12
14
16
18
1
2
3
4
5
6
7
8
9
10
11
SAMPLING AREA

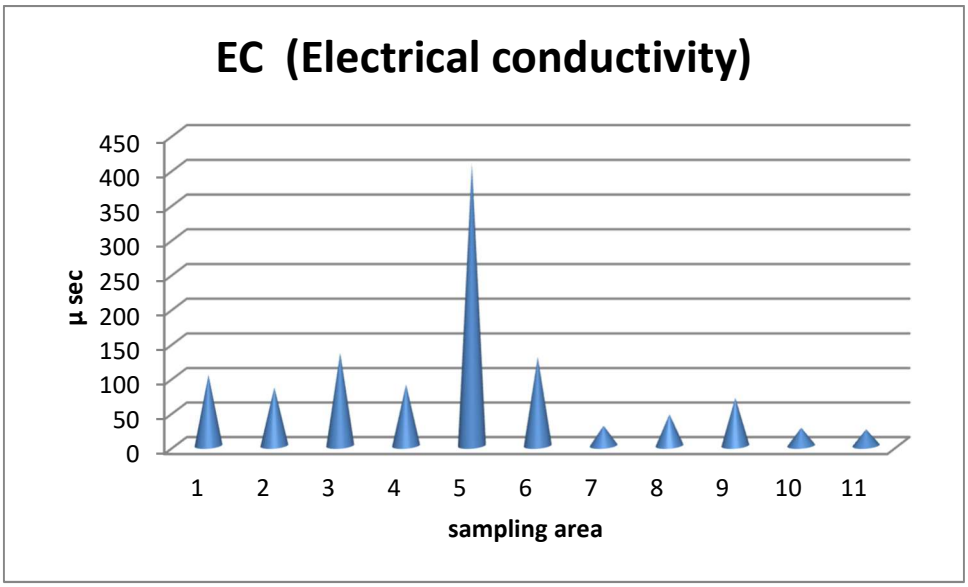
GRAPH: 3.GRAPHICAL PRESENTATION OF CHEMICAL PARAMETER

SAMPLE: 3






PH(Acid base valve)
100%
80%
60%
40%
20%
0%
PH
1 2 3 4 5 6 7 8 9 10 11
SAMPLING AREA


EC (Electrical conductivity)
450
400
350
300
250
200
150
100
50
0
µ sec
1 2 3 4 5 6 7 8 9 10 11
sampling area

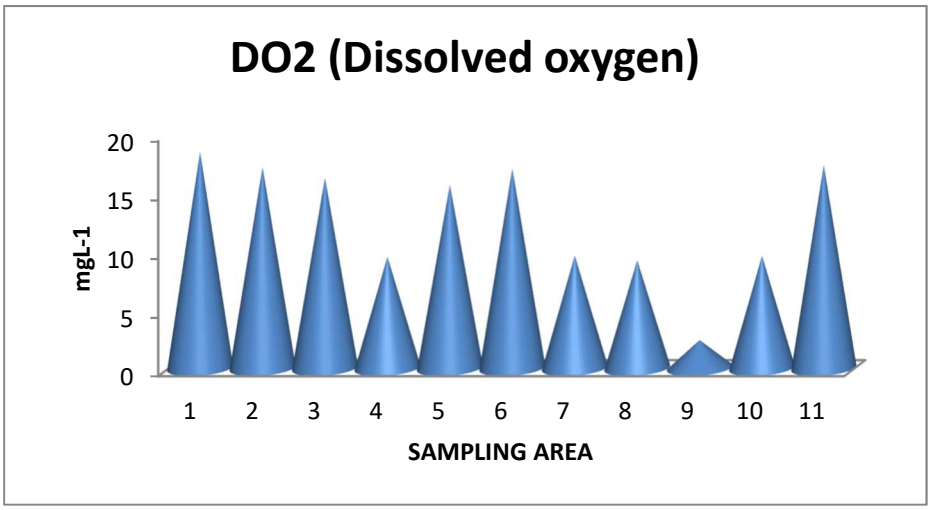

DO2 (Dissolved oxygen)
20
15
10
5
0
mgL-1
1 2 3 4 5 6 7 8 9 10 11
SAMPLING AREA

TABLE: 3 FISH BIOLOGICAL DESCRIPTION

Scientific Name	C.Name	V. Name	Classification	Climate Zone	Distribution	Biology	Feeding Habit	IUCN Red list status
Devario Malabaricus (Jerdon, 1849)	Malabar danio	Keyal Meen	Actinopterygii Cypriniformes Cyprinidae Danioninae	Tropical range	Asia, Western Ghats, Tamil nadu , Srilanka	Found in a variety of habitat from boulder – stream mountain torrents to small pools in dry zone streams.	Feeds on terrestrial insects and detritus	Least concern (LC)13 August 2019
Punitius denisonii (Day, 1865)	Denison barb	Kendai	Actinopterygii Cypriniformes Cyprinidae Barbinae sahyadria	Sub Tropical range	Endemic in India, Tamil nadu, Nilgiris	Inhabitant fast flowing hill stream herbivorous and gregarious fish	Herbivore s and gregarious fish	Endangered (EN)
Punitius dorsalis (Jerdan 1849)	Long snouted barb	Kendai	Actinopterygii Cypriniformes Cyprinidae Barbinae	Tropical	India & Sri lanka in particularly Tamil nadu, Kerala	occurs river, streams usually found in flowing water particularly with pebble substrate	Feeds on detritus, algae and higher plants	Endangered (EN)
Horalabiosa Joshuai (Silas, 1954)	Joshua Moklik	Minnows Carps	Actinopterygii Cypriniformes Cyprinidae No sub-family	High altitude	Asia, India , Tamil nadu	Inhabit mountain streams	Aquatic vegetation	Endangered (EN) 12 June 2010

CONCLUSION:

This study would be helpful to understand the status of the distributions climatic changes in Palani hills streams. This study will be useful to carry physic chemical Parameter of streams of Palani hills of South India (Table: 1). Based on my studies clear understanding physic chemical parameters can affected based on seasonality, distributional status of fresh water streams, and responsibility of fish bio diversity in a hills(Table:1a). Our Studies findings was given by graphical presentation (Graph1, 2, 3)

Though this study, the water quality assessment of freshwater of streams and rivers will be made helpful to living of endemic freshwater fishes and its ecology and physic chemical parameter analysis of streams of Palani hills was given ((Table:1a,2a,).Give little attention during different Seasonality, Distributional analysis study would be useful to understand the conservation status of freshwater streams fishes of Palani hills, and its endemic freshwater fishes biology studies useful to clear

evidence of their fish fauna diversity were collected through Fish base, Fish identification was given in the form of tabulated(Table:3). we concluded that fish diversity and distributional pattern based on their habitat seasonality,physio chemical parameters. finally future research to analysis molecular based studies to analysis their molecular characterization.

REFERENCE

1. Bruton, M.N. (1995). Threatened fishes of the world: Latimeria chalumnae Smith, 1939. (Latimeriidae). Environ. Biol. Fish. 43: 104pp.
2. Gibbs, J.P. (2000) Wetland loss and biodiversity conservation. Conserv. Biol 14(1):314–317
3. Hebert, P.D.N., Cywinska, A., Ball, S.L. & deWaard, J.R. (2003) Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London Series B, Biological Sciences*, **270**(1512), 313–321.
4. Jayaram, K.C. (1991). Revision of the Genus Puntius Hamilton. Records of the Zoological Survey of India – Occasional Paper No. 135, Zoological Survey of India, Kolkata, India.
5. Jayaram, K.c. (2010). The Freshwater Fishes of the Indian Region. Narendra Publishing House, Delhi, 616pp.
6. Sabuj Kumar Chaudhuri (2010) Fresh water fish diversity information system as a basis for sustainable fishery. Department of Library and Information Science, Jadavpur University, Kolkata-32
7. Arunachalam, M.; Raja, M.; Muralidharan, M. & Mayden, R.L. 2012. Phylogenetic relationships of species of Hypselobarbus (Cypriniformes: Cyprinidae): an enigmatic clade endemic to aquatic systems of India. Zootaxa 3499: 63-73.
8. Arunachalam, M. & Johnson, J.A. 2002. A new species of Puntius Hamilton (Pisces: Cyprinidae) from Kalakad, Mudanthurai Tiger Reserve, Tamil Nadu, India. Journal of Bombay Natural History Society 99(3): 474-480.
9. Arunachalam M.; Chinnaraja S. & Mayden, R.L. 2016. On the identity of B arbus (= Hypselobarbus) gracilis Jerdon (1849) and description of a new species of Hypselobarbus (Cypriniformes: Cyprinidae) from Western Ghats, peninsular India. FishTaxa 1(2): 75-83.
10. Bijukumar, A.; Siby Philip Anvar Ali, Sushama, S. & Raghavan R. 2013. Fishes of River Bharathapuzha, Kerala, India: diversity, distribution, threats and conservation. Journal of Threatened Taxa 5(15): 4979-4993.
11. Dinakaran, S., and Anbalagan, S. 2010. Spatio – temporal dynamics of Caddisflies in streams of Southern Western Ghats. J Insect Sci 10:46

12. Eschmeyer WN, Fricke R (2012) Catalog of fishes electronic version (20 December, 2013). Electronic database accessible at http:// research.calacademy.org /research/ichthyology/ catalog/ fishcatmain.asp/.

13. Menon AGK (1999) Check list-Fresh water fishes of India. Records of the Zoological Survey of India. Misc Publ 175: 1-366.

14. Froese R, Pauly (2012) Fish Base. World Wide Web Electronic Publication Available: www.fishbase.org Accessed: 2012 Dec 28.

15. Leveque C, Oberdorff T, Paugy D, Stiassny MLJ, Tedesco PA (2008) Global diversity of fish (Pisces) in freshwater. Hydrobiologia 198: 545-567.

16. Hoagland KE (1996) the Taxonomic Impediment and the Convention on Biodiversity. ASC News 24: 66-67.

17. Pethyagoda R, Kottelat M (1994) Three new species of fishes of the genera Osteochilichthys (Cyprinidae), Travancoria (Balitoridae) and Horabagrus (Bagridae) from the Chalakudy River Kerela India. J South Asian Nat Hist 1: 97-116.

18. Lakra WS, Singh M, Goswami M, Gopalakrishnan A, Lal KK (2015) DNA barcoding Indian freshwater fishes. Mitochondrial DNA 1-8.

19. Mendonca A, Cunha A, Chakrabarti R (2012) Natural Resources, Sustainability and Humanity: A Comprehensive View, Springer.

20. Waugh J (2007) DNA barcoding in animal species: progress, potential and pitfalls. Bioessays 29: 188-197.

21. Becker S, Hanner R, Steinke D (2011) Five years of FISH-BOL: brief status report. Mitochondrial DNA 22: 3-9.

22. Liu H, Chen Y (2003) Phylogeny of the East Asian cyprinids inferred from sequences of the mitochondrial DNA control region. Can J Zool 81: 1938-1946.

23. Day, F. 1871. Monograph of Indian Cyprinidae, Parts 13. Journal of Asiatic Society, Bengal 40: 95-142, 277-367.

24. Day, F. 1873. Report of freshwater fish and fisheries of India and Burma. Government Press, Calcutta. Day, F. 1878. The Fishes of India; being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Ceylon, part 4. William Dawson & Sons Ltd. London.

25. Hora, S.L. & Law, N.C. 1941. The freshwater fishes of Travancore. Records of the Indian Museum 43(1): 9-27. Hubbs, C.L. & Lagler, K.F. 1964. Fishes of the Great lakes region. University of Michigan Press. USA.

26. ICZN (International commission on Zoological Nomenclature) (1999). International Code of Zoological Nomenclature. International Trust for Zoological Nomenclature, The Natural History Museum, London.

27. Jayaram, K.C. 1991. Revision of the genus Puntius Hamilton from the Indian region (Pisces: Cypriniformes, Cyprinidae, Cyprininae). Records of the Zoological Survey of India, Occasional Paper 135: 1-178.

28. Jerdon, T.C. 1849. On the freshwater fishes of southern India. Madras Journal of Literature and Science 15(2): 302-346. Johnson, J.A. & Arunachalam, M. 2009. Diversity, distribution and assemblage structure of fishes in streams of southern Western Ghats, India. Journal of Threatened Taxa 1(10): 507-513.

29. Knight, J.D.M.; Rai, A. & D'Souza, R.K.P. 2013. On the identities of Barbus mussullah Sykes and Cyprinus curmuca Hamiltion with notes on the status of Gobio canarensis Jerdon (Teleostei: Cyprinidae). Zootaxa 3750(3): 201-215.

30. Menon, A.G.K. & Rema Devi, K. 1995. Hypse lobarbus kurali (Pisces: Cyprinidae), a new large barb from the south western rivers of peninsular India. Journal of Bombay Natural History Society 92(3): 389-393.

31. Radhakrishnan, K.V. & Kurup, B.M. 2010. Ichthyodiversity of Periyar Tiger Reserve, Kerala, India. Journal of Threatened Taxa 2: 1192-1198.

32. Raj, S.B. 1941. Barbus (Puntius) ophicephalus (type locality: Kallar, a tributary to the Pambiyar river, to the south of Pachakani estate adjoining Periyar Lake). Records of the Indian Museum 43: 375.

33. Rajan, S. 1955. Notes on a collection of fish from the head waters of the Bhavani River, South India. Journal Iran. J. Ichthyol. (June 2016), 3(2): 73-81 of Bombay Natural History Society 53: 44-48.

34. Shaji, C.P.; Easa, P.S. & Gopalakrishnan, A. 2000. Freshwater fish diversity of Western Ghats, 33-55: In: Ponniah, A.G. & Gopalakrishnan, A. (eds.). Endemic Fish Diversity of Western Ghats. NBFGR-NATP Publication, National Bureau of Fish Genetic Resources, Lucknow, U.P. India.

35. Thomas, R.K.; Biju, C.R.; Aithkumar, C.R. & George, M.J. 2000. Fish Fauna of Idukki and Neyyar Wildlife sanctuaries of Kerala, S. India. Journal of Bombay Natural History Society 97: 442-445.

36. Venkateshwarlu, M.; Arun Kumar Shetty, B. & Kiran, B.R. 2014. Conservation status of fish diversity of rivers-Sita, Swarna and Varahi in Udupi district, Western Ghats, Karnataka, India. International Journal of Advanced Scientific and Technical Research 1(4): 797-813.

37. Yang, L.; Hirt, V.; Sado, T.; Arunachalam, M.; Manickam, R.; Tang, K.L.; Simons, A.M.; Wu, H.H.; Mayden, R. & Miya, M. 2012. Phylogenetic placements of the barbin genera Discherodontus , Chagunius , and Hypselobarbus in the subfamily Cyprininae (Teleostei: Cypriniformes) and their relationships with other barbins. Zootaxa 3586: 2640.

38. Zacharias, V.J.; Bhardwaj, A.K. & Jacob, P.C. 1996. Fish fauna of Periyar Tiger Reserve. Journal of Bombay Natural History Society 93: 38-43.

39. Myers, N.Mittermeter, R.A., Mittermeter, C.G., da Fonseea, G.A. B., and Kent, J.2000. Biodiversity hotspots for conservation priorities. Nature 403:853-858

40. Dahanukar, N., Raut, R., and Bhat, A. 2004. Distribution, endemism and threat status of freshwater fishes in the Western Ghats of India J. Biogeogra. 31:123-136.

41. Day, F. 1865. The Fishes of Malabar. Bernard Quaritch, London, pp 293.

42. Day, F. 1878 The Fishes of India Being a Natural History of Fishes known to Inhabit the seas and Freshwaters of India, Burma and Ceylon Bernard Quaritch, London pp 778.

43. Hora, S.L. 1942. A list of fishes of Mysore State and neighbouring hill ranges of the Nilgris, Wynaad and Coorg. Rec. Indian Mus. 44, 193-200

44. Hora, S.L., and Law, N.C., 1941. The freshwater fishes of Travancore. Rec. Indian Mus. 43:233-256

45. Silas, E.G. 1951. On a collection of fish from the Anamalai and Nelliampathi Hill ranges (Western Ghats) with notes on its zoogeographical significances. J. Bombay Nat. Hist. Soc. 49:670-681

46. Arunachalam M. and Manimekalan, A. 2000. In: Economically important and cultivable fishes of the Nilgiri biosphere reserve. Endemic fish diversity of Western Ghats (Eds: Ponniah, A.G., and Gopalakrishnan, A.,) NBFGR-NATP publication, India pp 237-239

47. Arunachalam, M.2000. Assemblage structure of stream fishes in the Western Ghats (India). Hydrobiologia, 430:1-31

48. Manimekalan, A., and Singh, D. F. 1997. New record Schismatorhynchus (Nukta) nukta (Sykes) (Pisces: Cyprinidae) from Moyar river, extends its range to Tamil Nadu, J. Bombay Nat. Hist. Soc. 94:170-171

49. Arunachalam, M., Sivakumar, P. and Muralitharan, M.2005. Habitat evaluation of pristine headwater streams of Western Ghats mountain ranges, Peninsula India, in: New trends in Fishery Development in India, Ed: Johal, M.S., Punjab University, India, pp 253-286