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Observations on ichthyofauna and water quality of Pili reservoir in district Bijnor of Uttar Pradesh

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Abstract
The present study deals with the fish fauna and water quality of Pili reservoir in Bijnor district, Uttar Pradesh. Monthly sampling was undertaken during January 2013 to December 2013. Identification of the fish samples and analysis of water samples were undertaken following standard protocols. Data were subjected to appropriate statistical treatments. The results of present investigation revealed the occurrence of 31 fish species belonging to five orders, 11 families and 21 genera. The order Cypriniformes was found dominant (18 species) followed by Siluriformes (eight species), Perciformes (two species), Osteoglossiformes (two species) and Synbranchiformes (one species). The range of different physico-chemical parameters were: observed such as water temperature 16.5 ºC-36 ºC; pH 7.4-9.1; Dissolved Oxygen 3.8-8.4 mg/l; Free Carbon-dioxide nil-4.5 mg/l; Chloride 14.5-30.2 mg/l; Nitrate 0.04-0.58 mg/l and Phosphate 0.13-0.19 mg/l. The results indicated that the Pili reservoir is under category of meso-eutrophic water body.

Keywords: Ichthyofauna, Pili reservoir, Physico-chemical parameters.

1. Introduction
Reservoirs are primarily used for irrigation, flood control, industrial and domestic water supply and for power generation. Besides these uses, they offer immense fish production potential and livelihoods for fisher communities. Since independence many river valley projects, resulting in the formation of several reservoirs, have come up in the country. India has 19,370 reservoirs spread over 15 states with an estimated 3.15 million ha surface area at full capacity, and this is expected to increase further due to execution of various water projects in the country [1]. In spite of this fact, reservoir fish production has been treated as a by-product, and reservoir fisheries have not made significant progress in the country [2]. Indian reservoirs comprise about 50% of the total reservoir area in Southeast Asia [3]. The reservoirs, therefore, form prime inland fishery resources of the country. The state of Uttar Pradesh is an agriculture-dominated state of India. To meet its irrigation requirements, many reservoirs have been created. Sixty-six reservoirs with an area of 1,37,034 ha are distributed among 17 districts of Uttar Pradesh [4].

Fisheries occupy an important place in the economy of India. The industry has enormous employment and export potential. Fish being rich in highly digestible quality proteins, can supplement the protein deficient diet of the people. Fishes are also a good source of unsaturated fatty acids, vitamins and minerals. Reservoirs contribute as the single largest inland fishery resource both in terms of size and production potential. Fish fauna of a reservoir basically represents the fish diversity and their abundance. Indian reservoirs preserve a rich variety of fish species, which supports to the commercial fisheries. In Uttar Pradesh, Bijnor district is one of the richest in aquatic resources that include river tributaries apart from a reservoir and few lakes. The Bijnor district is one of the important districts for fish production and natural water resources and there is great scope for developing fisheries in this region. However, there is no published information on the fish diversity in Pili reservoir of Bijnor. The objectives of the present study were to (i) study faunal diversity of the fish species present in Pili reservoir, and (ii) physico-chemical characteristics of water in the reservoir.

2. Materials and Methods

2.1 Description of the Study Area

Pili reservoir was constructed on Pili River in 1966. The reservoir is situated near Rehar village, Afzalgarh in Bijnor district, Uttar Pradesh. Pili reservoir is located at latitude 29° 21'N to 29° 24'N and longitude 78°46' E to 78°49'E. The catchment area at site is about 162 km^2. Other features and specifications of the dam include: Height of reservoir=18.29 m, Length of reservoir=15.40 km, Maximum storage level=257.86 m, Dead storage level=246.89 m, Top elevation of reservoir=260.67 m (855ft), Top width of reservoir=6 m (20 ft) and maximum spillway capacity=24000 cusecs (courtesy: Afzalgarh Irrigation Division, Moradabad) (Figure 1).

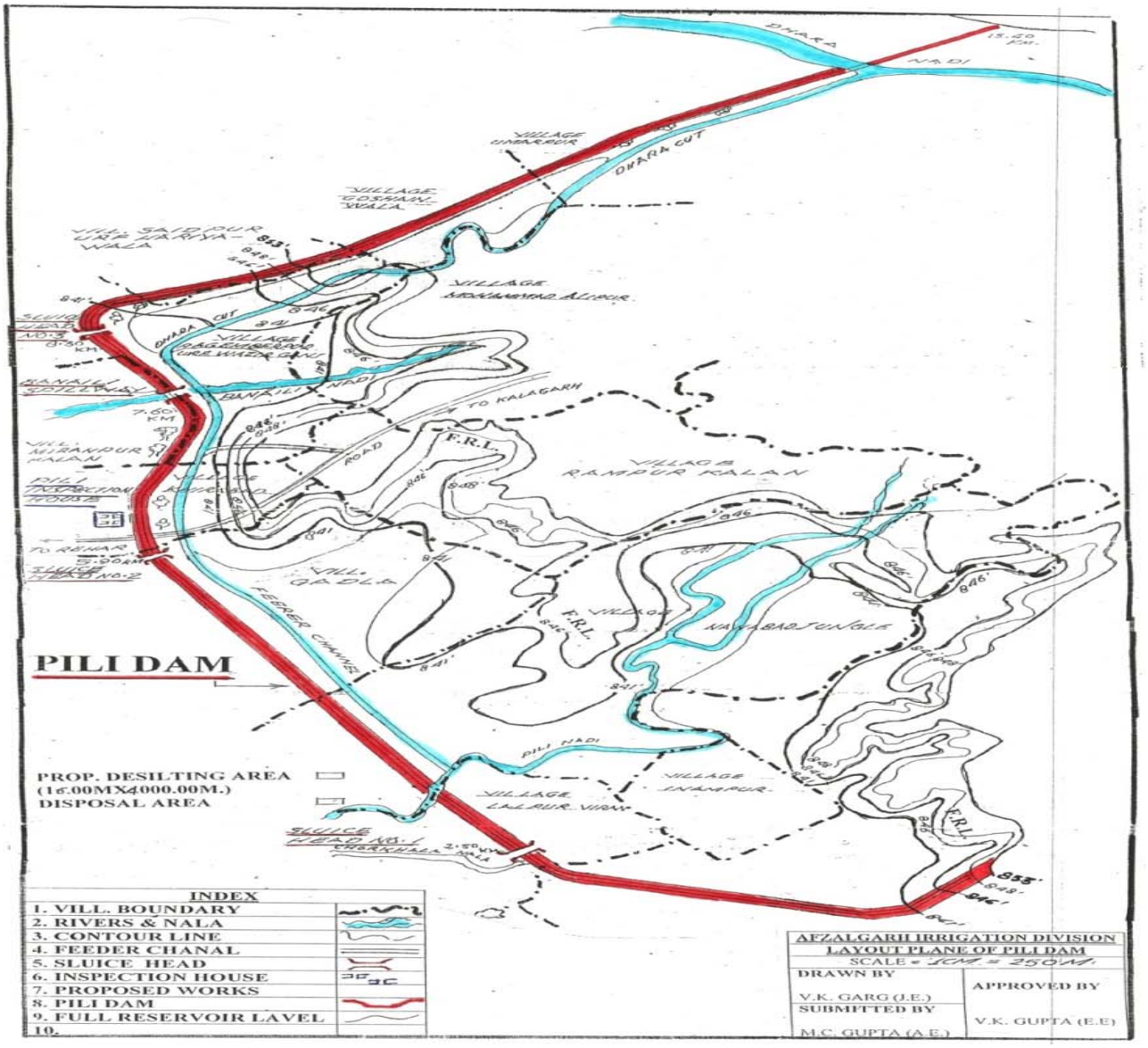


Fig 1: Map showing Pili reservoir at Rehar Village, Afzalgarh in Bijnor district

The main objective of the reservoir was to fulfill the irrigation demands and to control water floods; the reservoir currently supports a thriving fishery, which offers enormous opportunities for increasing freshwater fish production in the region.

2.2 Sampling and Analysis

The fishes were collected from the Pili reservoir with the help of local fishermen during the year January 2013 to December 2013 using different types of nets, viz., gill nets and cast nets. Fish identification was done with the help of standard taxonomic references [5, 6, 7].

The water samples for physico-chemical analysis were collected from Pili reservoir between 8 a.m. to 11 a.m. in the first week of every month from January 2013 to December 2013. Water temperature was measured at the time of sampling using mercury thermometer, pH was measured with standard pH meter, while other parameters were analyzed in the laboratory according to the methods suggested by Trivedy and Goel (1986) and APHA (1998) [8, 9]. All Statistical analysis was done using MS-Excel and SPSS (Version 16) [10].

3. Results and Discussion

The hydro-biological features of the collection centers play an effective role in fisheries output to a great extent. Thirty one species belonging to five orders, nine families and 21 genera were found in this reservoir (Table 1).

Table 1: Fish Fauna in Pili Reservoir of district Bijnor

S. No.	Order	Family	Scientific name of Fishes
1.	Cypriniformes	Cyprinidae	*Catla catla* (Ham.)
2.			*Cirrhinus mrigala* (Ham.)
3.			*C. reba* (Ham.)
4.			*Cyprinus carpio* (Linnaeus)
5.			*Labeo rohita* (Ham.)
6.			*L. calbasu* (Ham.)
7.			*L. gonius* (Ham.)
8.			*L. bata* (Ham.)
9.			*Puntius sarana* (Ham.)
10.			*P. ticto* (Ham.)
11.			*P. sophore* (Ham.)
12.			*Chela bacaila* (Ham.)
13.			*Ctenopharyngodon idella* (Valenciennes)
14.			*Hypophthalmichthys molitrix* (Valenciennes)
15.			*Esomus danricus* (Ham.)
16.			*Amblypharyngodon mola* (Ham.)
17.			*Oxygaster bacaila* (Ham.)
18.			*O. gora* (Ham.)
19.	Siluriformes	Siluridae	*Wallago attu* (Bloch and Schneider)
20.		Bagridae	*Sperata seenghala* (Sykes)
21.			*Mystus cavasius* (Ham.)
22.			*M. vittatus* (Bloch)
23.		Sisoridae	*Bagarius bagarius* (Ham.)
24.		Heteropneustidae	*Heteropneustes fossilis* (Bloch)
25.		Clariidae	*Clarias batrachus* (Linnaeus)
26.			*C. gariepinus* (Burchell)
27.	Perciformes	Channidae	*Channa srtiatus* (Bloch)
28.			*Channa punctatus* (Bloch)
29.	Synbranchiformes	Mastacembelidae	*Mastacembelus armatus* (Lacepede)
30.	Osteoglossiformes	Notopteridae	*Notopterus notopterus* (Pallas)
31.			*Chitala chitala* (Ham.)

Out of the 31 species, one species of *Catla* (*C. catla*), two species of *Cirrhinus* (*C. mrigala* and *C. reba*), one species of *Cyprinus* (*C. carpio*), four species of *Labeo* (*L. rohita, L. calbasu, L. gonius and L. bata*), three species of *Puntius* (*P. sarana, P. ticto and P. sophore*), one species of *Chela* (*C. bacaila*), one species of *Ctenopharyngodon* (*C. idella*), one species of *Hypophthalmichthys* (*H. molitrix*), one species of *Esomus* (*E. danricus*), one species of *Amblypharyngodon* (*A. mola*), two species of *Oxygaster* (*O. bacaila* and *O. gora*), one species of *Wallago* (*W. attu*), one species of *Sperata* (*S. seenghala*), two species of *Mystus* (*M. cavasius* and *M. vittatus*), one species of *Bagarius* (*B. bagarius*), one species of *Heteropneustes* (*H. fossilis*), two species of *Clarias* (*C. batrachus* and *C. gariepinus*), two species of *Channa* (*C. striatus* and *C. punctatus*), one species of *Mastacembelus* (*M. armatus*), one species of *Notopterus* (*N. notopterus*) and one species of *Chitala* (*C. chitala*) were observed from the selected reservoir. Ichthyofaunal diversity comprised of nine families namely Cyprinidae (58.06%), Bagridae (9.67%), Clariidae (6.45%) Channidae (6.45%), Notopteridae (6.45%) Sisoridae (3.22%), Mastacembelidae (3.22%), Heteropneustidae (3.22%) and Siluridae (3.22%) (Figure 2).

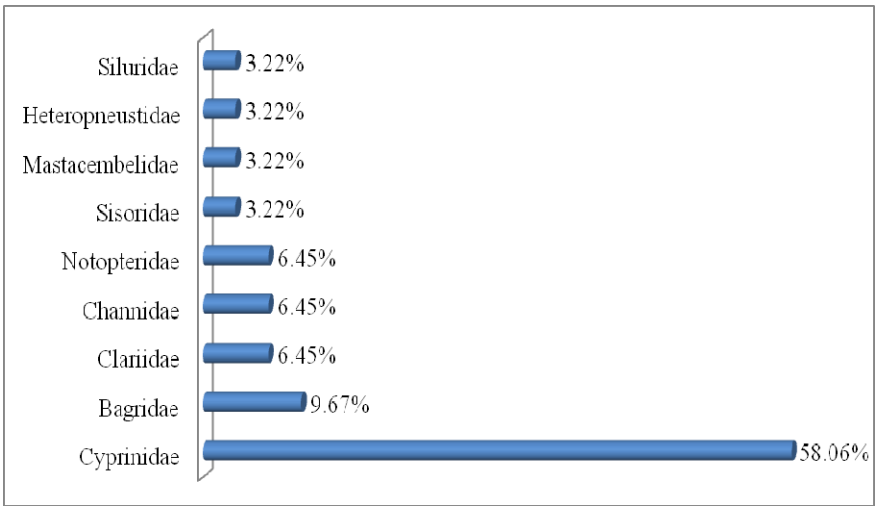


Fig 2: Percentage contribution of different families of fishes of Pili reservoir

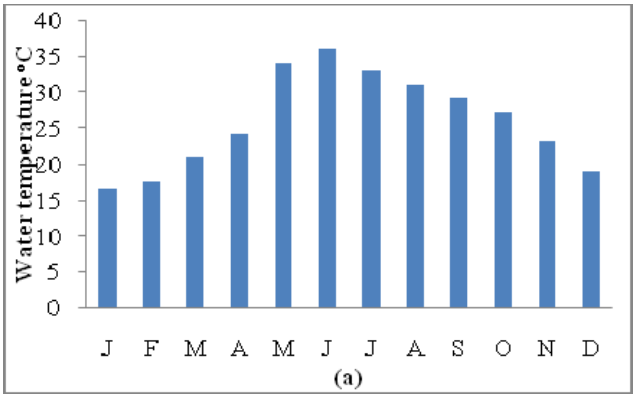
Cyprinid fishes are found to be the more dominant group than others, which is supported by other studies also. Khedkar (2005) [11] observed 67 fish species belonging to seven orders and 19 families from Nathsagar reservoir from Paithan District, Aurangabad. Shahnawaz *et al.* (2009) [12] recorded 56 species of fishes in Bhadra river of Western Ghats (India), Korai *et al.* (2008) [13] recorded 51 fish species from Keenjhar lake of Pakistan. Shinde *et al.* (2009) [14] reported a total of 15 species belonging to three orders, four families and 12 genera in Harsool Savangi Dam, Aurangabad. The order Cypriniformes was found dominant with 11 species, followed by Perciformes with three species and Siluriformes with one species. Rankhamb (2011) [15] reported the occurrence of 26 fish species belonging to five orders, seven families and 15 genera in Godavari River at Mudgal. The members of the order Cypriniformes dominated by 15 species, followed by Siluriformes with five species, Channiformes with four species and Mastacembeliformes and Perciformes with one species each. Nagma and Khan (2013) [16] reported a total of 36 fish species belonging to six orders, 11 families and 23 genera from various water resources of Bijnor district. They reported the dominance of order Cypriniformes with 18 species, followed by Siluriformes (10 species), Perciformes (four species), Osteoglossiformes (two species), Synbranchiformes and Clupeiformes (one species each).

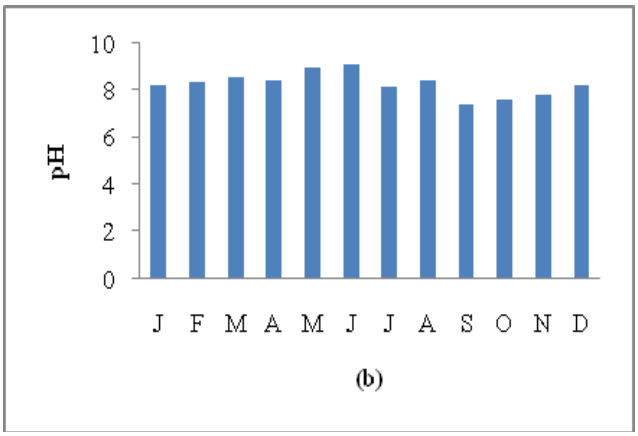
Physico-chemical analysis is the prime consideration to assess the quality of water for its best utilization like drinking, irrigation and fisheries. It also helps in understanding the complex processes, interaction between the climatic and biological processes in water.

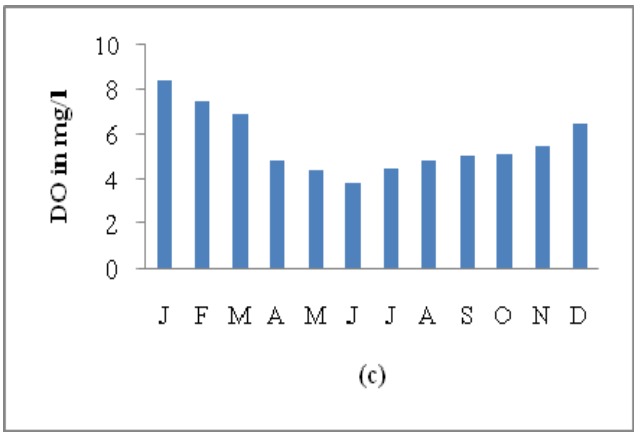
The range of variations and mean values along with standard error of physico-chemical characteristics of water during January 2013 to December 2013 are given in Table 2. The monthly variation in physico-chemical parameters has been presented in Figure 3. The values of coefficient of correlation (r) between various physico-chemical parameters of water in Pili reservoir were calculated and trophic status of reservoir have been shown in Table 3.

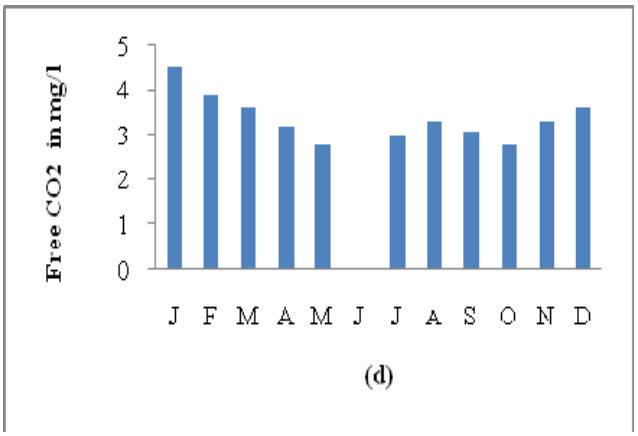
Table 2: Range of variations and mean with standard error of physico-chemical parameters of water of Pili reservoir during January 2013 to December 2013.

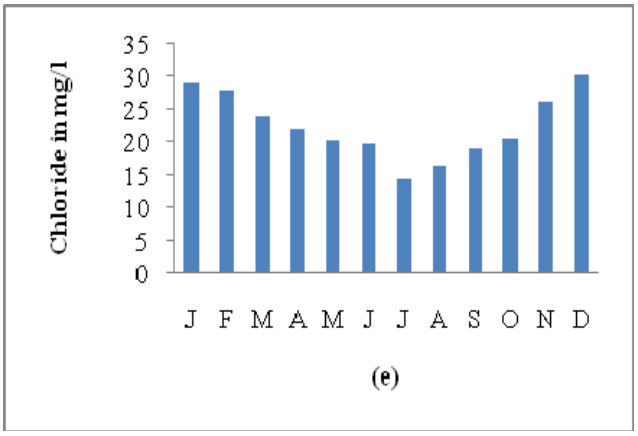
Parameters	Range	Mean	SD
Temperature	16.5-36	25.91	6.72
pH	7.4-9.1	8.25	0.50
DO	3.8-8.4	5.60	1.40
Free Carbon Dioxide	0.0-4.5	3.09	1.08
Chloride	14.5-30.2	22.51	5.04
Nitrate	0.04-0.58	0.15	0.19
Phosphate	0.13-0.19	0.15	0.001

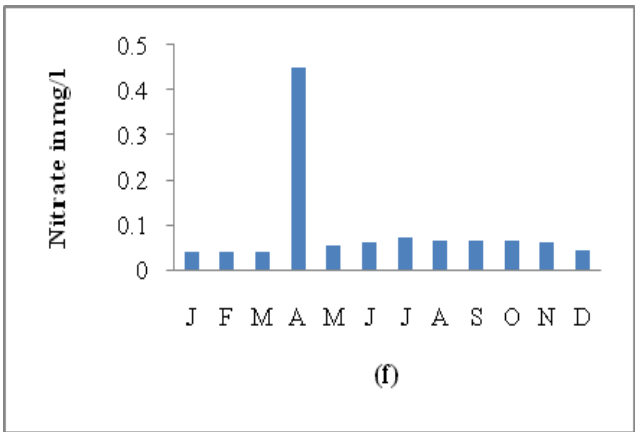












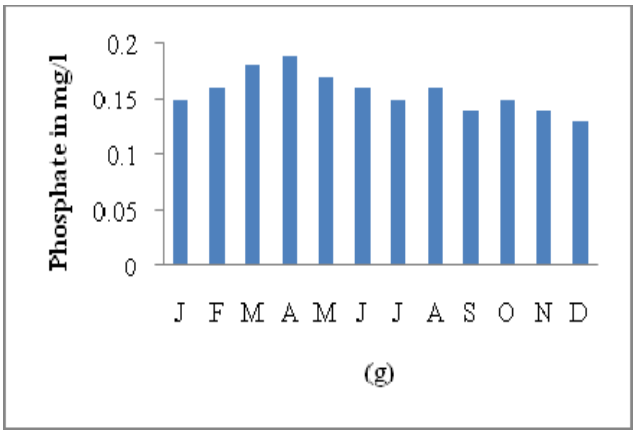


Figure 3. Monthly variation in (a) Water temperature, (b) pH, (c) DO, (d) Free CO_2, (e) Chloride, (f) Nitrate and (g) Phosphate in Pili reservoir.

Table 3: Trophic status of the Pili reservoir on the basis of different indices

S. No.	Parameters	Trophic status of reservoir	References
1	Water temperature (ºC)	Meso-thermal (15 to 40)	Lee *et al.* (1981)
2	pH	Alkaliphilous (7.5 to 9.0)	Venkateswarlu (1983)
3	Free carbon-dioxide (mg/l)	Soft (Nil to 4.3)	Reid and Wood (1976)
4	Chloride (mg/l)	Less domestic pollution (17.9 to 57.6 mg/l)	Unni (1983)
5	Nitrate-nitrogen (mg/l)	Eutrophic (0.15-0.75 mg/l)	Vollenweider (1968)
6	Phosphate (mg/l)	Eutrophic (>0.04 mg/l)	Lee *et al.* (1981)

Temperature of a water body depends upon the time of collection, season and water depth and has both direct and indirect effects on the water body. In the present study, water temperature ranged from 16.5 °C to 36 °C with an annual mean of 25.91 ºC ± 6.72. The maximum (36 °C) temperature was recorded in the month of June and minimum (16.5 °C) in the month of January. Water temperature plays an important role in influencing the chemical, biochemical and biological characteristics of water body. Similar observations were reported in Wanparakalpa reservoir Nagpur, (Salve and Hiware, 2008) [17], in Anjanapura reservoir Karnataka, (Narayana *et al.*, 2008) [18], in Ramsagar reservoir Datia Madhya Pradesh, (Garg *et al.*, 2009) [19], in Kankaria lake, Ahemdabad (Verma *et al.*, 2011) [20], and Krishnagiri dam, Tamil Nadu (Prabhakar *et al.*, 2012) [21].

pH- (Hydrogen Ion Concentration) indicates acidity or alkalinity of water and plays a significant role in productivity of a water body. Water of Pili Reservoir was found alkaline in nature and range of pH varied from 7.4 to 9.1with an annual mean of 8.25ºC ± 0.50. The maximum pH value (9.1) was recorded in the month of June and minimum (7.4) in the month of January. Higher values of pH were recorded during summer months. Input of sewage and agricultural waste are also responsible for higher values of pH in water. Kaushik & Saksena (1991), Dagaonkar & Saksena (1992), Kumar *et al.* (2009) and Sinha & Biswas (2011) [22, 23, 24, 25] have also reported similar trend in pH variation in Suraj kund, Kailasagar, Keenjhar lake and Kalyani lake, respectively.

Dissolved Oxygen in water is of great importance to all aquatic organisms and is considered to be the one factor which to a great extent can reveal the nature of whole aquatic system. It is important in the production and support of life. It is also necessary for the decomposition and decaying of organic matter. The values of DO fluctuated from 3.8 mg/l to 8.4 mg/l with an annual mean of 5.60ºC ± 1.40. The maximum value (8.4 mg/l) was recorded in the month of January and minimum values (3.8 mg/l) in the month of June. Dissolved Oxygen has been attributed a great significance as an indicator of water quality especially the magnitude of eutrophication. Dissolved Oxygen concentration in water depends mainly upon temperature, dissolved salts, velocity of wind, pollution load, photosynthetic activity, and respiration rate (Tamot *et al.*, 1990, Zutshi *et al.*, 1990) [26, 27].

In the present study, free carbon dioxide fluctuated between nil and 4.5 mg /l with an annual mean of 3.09ºC ± 1.08.The maximum value (4.5 mg/l) was recorded in the month of January and minimum value (nil) in the month of June. The free carbon dioxide level in water is decreased due to photosynthesis by algae and macrophytes and increased due to the respiration of all aquatic organisms. The presence or absence of the free carbon dioxide in surface water is mostly governed by its utilization by algae during photosynthesis and also through its diffusion from air. It may be emphasized that free carbon dioxide was lower in summer and higher in winter seasons. In Pili reservoir, higher value of free carbon dioxide is possibly due to the decomposition of organic matter, low photosynthetic activity and low precipitation of free carbon dioxide as carbonates. Similar observations were reported by Sakhare & Joshi (2002) [28] in Palas-nilegaon in Osmanabad district Maharastra, Pazhanisamy & Ebanasar (2008) [29] in Lower Analcut reservoir of Thanjavur district Tamil Nadu and Ahangar *et al.* (2012) [30] in Anchar lake, Kashmir.

Chlorides occur naturally in all types of water. In natural fresh waters, however, their concentration remains quite low and generally less than that of sulphate and bicarbonate. The values of chlorides ranged from 23 mg/l to 51 mg/l with an annual mean of 22.51ºC ± 5.04. The maximum value (51 mg/l) was recorded in the month of June and minimum value (23 mg/l) in the month of January. Similar results were reported by Swarnalatha and Narsing Rao (1998) [31] in Banjara lake and Sinha & Biswas (2011) [25] in Kalyani lake.

In the present investigation the Nitrate values ranged from 0.62 to 1.12 mg/l with an annual mean of 0.15ºC ± 0.19. The maximum value (1.12mg/l) was observed in the month of July and minimum (0.62mg/l) in the month of February. This may be due to the high decomposition of organic matter. Similar observations were also reported by other researchers working

on different water bodies (Garg *et al.* 2006, Sinha & Biswas 2011, Prabhakar *et al*. 2012) [32, 25, 21].

Phosphate is an important plant nutrient and plays a role in primary productivity of the water body. The values of phosphate ranged from 0.13 to 0.19 mg/l with an annual mean of 0.15ºC ± 0.01. The maximum value (0.19mg/l) was observed in the month of April and minimum (0.13mg/l) in the month of December.

3.1 Correlation among physico-chemical characteristics

It has been pointed out in several studies that the physico-chemical characteristics influence each other and biological features of the water body. In the present study, the water temperature showed significant and negative correlation with DO, carbon dioxide and chloride. Temperature showed insignificant correlation with pH, Nitrate and Phosphate. pH showed insignificant correlation with DO, free carbon dioxide, chloride, nitrate and phosphate. DO showed significant and positive correlation with free carbon dioxide and chloride. DO showed insignificant correlation with nitrate and phosphate. Free carbon dioxide showed significant and negative correlation with nitrate and insignificant with chloride and phosphate. Chloride showed insignificant with nitrate and phosphate. Nitrate showed significant and positive correlation with phosphate. Such a correlation of physico-chemical parameters has also been noted by several workers like Kumar *et al*. (2007) [33] in Sikanderpur reservoir Basti (U.P.), Garg *et al.* (2009 & 2010) [19, 34] in Harsi and Ramsagar reservoir, Gwalior, Madhya Pradesh and Ahangar *et al.* (2012) [30] in Anchar lake, Kashmir.

3.2 Trophic status of the water body

Nutrient level of any water body is directly related with its trophic status. A lake is usually classified as being in one of three possible classes: oligotrophic, mesotrophic and eutrophic. Both natural and anthropogenic factors can influence a lake or any other water body's trophic index. A water body situated in a nutrient rich region with high net primary productivity may be naturally eutrophic. There have been good number of parameters of water which are used to designate trophic status of a water body. Saksena and Kaushik (1994) [35] have designated Motijheel as mesotrophic, while Surajkund and Ranital as eutrophic on the basis of physico-chemical characteristics of water. Raghavendra and Hosmani (2002) [36] have reported the growth of phytoplankton in Mandakally lake and noted that the water body is tending fast to become eutrophic. Harsi reservoir was considered as oligo-mesotrophic water body which was due to the fact that no sewage or industrial waste is discharged to the reservoir and no agricultural practices are in vogue in the vicinity of the reservoir [32]. Garg *et al*. (2009) [19] have observed various parameters of Ramsagar reservoir and considered this water body as mesotrophic. Ahangar *et al*. (2012) [30] categorised Anchar lake under eutrophic water bodies due to the fact that it receive large amount of sewage and waste from neighbouring areas.

4. Conclusion

In conclusion, various physico-chemical characteristics of Pili reservoir like temperature, pH, free carbon dioxide, chlorides, phosphates and nitrate-nitrogen have been evaluated with that of the physico-chemical characteristics of water in different trophic status as assigned by various workers [37, 38, 39, 40, 41]. It has been found that Pili reservoir can be categorized as meso-eutrophic (Table 3) with rich amount of nutrients, which may be due to agricultural practices being undertaken by farmers in surrounding catchment area of this reservoir. Thus, the reservoir may serve as a good habitat for planktonic organisms and can also be very well used for further stocking of Indian major carps for their cultivation.

Water of Pili reservoir is alkaline and is favorable for fish culture and other aquatic biota. In the present investigation, it was concluded that the Pili Reservoir is a healthy water body providing a habitat for fresh water fishes of diverse type. However, there is constant threat to fish population due to eutrophication and illegal fishing activities. The illegal fishing activities should be banned to prevent depletion of fresh water fish resources. Further studies should be conducted to generate more details regarding seasonal production and ecology of fishes.

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