JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

"Studies on the Physico-Chemical Parameters Concerning the Diversity of Chlorophyceae and Cyanophyceae from the Dara Dam, Satpura Ranges of the Nandurbar district, Maharashtra, India"

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Abstract

The Physico-chemical parameter has great value in the aquatic ecosystem. It plays role in the biodiversity of algae. The present study, investigated the Physico-chemical parameter concerning the diversity of Chlorophyceae (Green Algae) and Cyanophyceae (Blue-Green Algae) from the area of Satpura Ranges of Nandurbar District, from Feb 2017 to Jan 2019. We identified 31 Species of Chlorophyceae and 29 Species of Cyanophyceae. The present study reveals that the Chlorophyceae is dominant over the Cyanophyceae. The present study shows that Physico-chemical parameters vary from place to place at the study site.

Keywords:
Physicochemical parameters, green algae, blue-green algae, biodiversity.

Introduction

On our earth planet, water is the most important aspect for living beings because almost all living things are dependent on water and cannot survive without water. Mainly the biodiversity of an aquatic organism depends upon the quality of water and is co-related with the terrestrial ecosystem (Parisara N, *et al* 2016). The quality of water is determined by Physico-chemical parameters. The Physico-chemical parameter of water is fluctuated by the interference of a human being directly or indirectly through drainage of organic and inorganic substances in water bodies changing the natural water quality "said to be water pollution" (Sakdeo, B.M. 2003). It may be caused by some natural climatic factors also. The fluctuation of living beings in aquatic ecological complexes is a good sign of man-made pollution (Bhaskar, K., et *al* 2015). The Physico-chemical parameter of water varies from season to season. In India, changes in the climatic factor are found at different localities for one year (Jyotsna, N., *et al* 2014). The Physico-chemical parameter shows the impact on the total biomass and diversity of phytoplankton.

Around 3.5 billion years ago; on earth, the only prokaryotic photosynthesizing algae to form a colony was Cyanophyceae, which make them unique from other organisms (Chakdar, H. *et al* 2012). It is cosmopolitan in distribution. It shows the great variety of habitats, such as marine water, brackish water, hot springs, in the soil, running water, stagnant water, rice field etc. The eutrophication is accretion by the human interference by disposing of sewage, agricultural bio-fertilizers etc. trigger the amplification of Cyanobacterial (BGA) blooms which change the water into bad taste and odours, increase turbidity which makes the water non-drinkable (Tiwari, A., & Chauhan, S. V. S. 2006). The

alkalinity of soil helps for the growth of Cyanophycean (BGA) members and shows so greater variety and variability (Jain N. *et al* 2017).

All the Chlorophycean members are eukaryotic organisms commonly known as green algae. Because of the presence of dominant pigment like chlorophyll "a" and "b" (Sarojini, Y., Neelima, P., & Sujat, B. 2015). The green algae are like a higher plant based on chlorophyll a and b pigment, reserve food material as starch and the arrangement of lamellae to form grana and inter-granal region and makes the organization of chloroplast fine (Happey-Wood, V.M. 1988). It shows unicellular motile to multicellular complex filamentous branched thallus organization (Lewis, L. A., & McCourt, R. M. 2004). The members of Chlorophyceae are like Cyanophyceae, widely distributed all over the world. Chlorophycean members are dominant among the phytoplankton community because they can grow in extreme conditions where other microorganisms cannot survive. Therefore, they may be used as biosensors of the aquatic ecosystem for severe changes (Brayner, R., *et al.* 2011).

Materials and Methods

The present study was carried out from the Dara Dam of the Satpura ranges of the Nandurbar district. A water sample has been collected at the 30-day interval. The possible parameters like TDS, pH, and temperature have been taken at the collection site with the help of a portable digital pH meter and a mercury thermometer. For the collection of the water sample, airtight plastic bottles were used. The water parameters such as O_2, CO_2, alkalinity, BOD, COD, and total hardness were carried out in the laboratory as per the standard method (Federation, W. E., & Aph Association, 2005).

The algal materials were randomly collected from the study site in separate plastic bottles. The collected materials were brought to the laboratory and washed with water and preserved in 4% formaldehyde for further microscopic study. The algal materials were identified with the help of standard monographs and the latest literature. The members of Chlorophyceae were identified with the help of the descriptions of monographs of different orders and families. The following monographs were used for the identification of algal taxa, "Volvocales" Iyengar, M.O.P. and Desikachary, T.V. (1981); "Chlorococcales" Philipose, M.T. (1967); "Ulotrichales" Ramanathan, K. R. (1964); "A Monograph of the British Desmidiaceae" Vol-I, Vol-II, Vol- Vol-III and Vol-IV; West, W., & West, G. S. (1904; 1905; 1908; 1911); "A Monograph of the British Desmidiaceae" Vol-V; Carter, N. (1923); "Indonesian desmids" Scott, A.M. and G.W. Prescott (1961); "Algal Flora of Korea" Lee, O.M. (2015); "The British Desmidieae" Ralfs, J. (1848); "Zygnemataceae" Randhawa, M. S. (1959) and "Oedogoniales" Gonzalves, E. A. (1981) etc. Some online research papers also refer to the identification algal taxa.

Results and Discussion

The reported algal taxa from the Dara Dam.

Chlorophyceae

Actinotaenium capax (Joshua) Teil. var. *minus* (Schmidle) Teil., *Characium ambiguum* Hermann ex Rabenhorst, *Closterium leibleinii* Kutz, *Coelastrum microporum* Naegeli, *Cosmarium furcatospermum* West and G.S. West, *Cosmarium pyramidatum* (Breb.), *Microspora crassio*r (Hansgirg) Hazen, *Mougeotia calcarea* (Cleve) Wittrock, *Oedogonium irregular* var. *condensatum* (Hallas) Hirn, *Oocystis borgei* Snow, *Scenedesmus prismaticus* Bruhl & Biswas, *Scenedesmus quadricauda* var. *longispina* (Chodat) G.M.Smith, *Selenastrum minutum* (Naegeli) Collins, *Spirogyra formosa* (Transeau) Czurda, *Spirogyra puncticulata* Jao, *Stauridium tetras* (Ehrenberg) E. Hegewald var. *apiculatum* (Fritsch) Keshri et Mallick, *Tetraedron muticum* (Reinsch) Hansgirg, *Trochiscia aspera* (Reinsch) Hansgirg, *Ulothrix variabilis* Kuetzing, *Uronema africanum* Borge, *Zygnema insigne* (Hassal) Kutzing etc.

Cyanophyceae

Anabaena iyengarii Bhardwaja etc. *Aphanothece castagnei* (Breb.) Rabenh, *Aphanothece conferta* Richter, *Chroococus montanus* Hansgirg, *Gleotrichia pisum* Thuret ex Born. et Flash, *Gloecapsa compacta* Kutz, *Gloeocapsa rupestris* Kutz, *Gloethece rupestris* (Lynb.) Bornet, *Lyngbya majuscule* (Dillwya) Harvey, *Merismopedia punctata* Meyen, *Nostoc piscinale* Kutzing ex Born et Flash, *Oscillatoria boryana* Bory ex Gomont, Oscillatoria irrigua (Kiitz.) Gomont, *Oscillatoria princeps* Vaucher ex Gomant, *Oscillatoria subbrevis* Schmidle, *Phormidium purpurascens* (Kutz.) Gomont, *Schizothrix friessi* (Ag.) Gomont.

Physico-chemical parameter analysis was carried out in the Dara dam from February 2017 to January 2019 for the analysis of water quality.

Graphical Presentation of Physico-chemical parameter analysis Feb 2017-Jan 2019

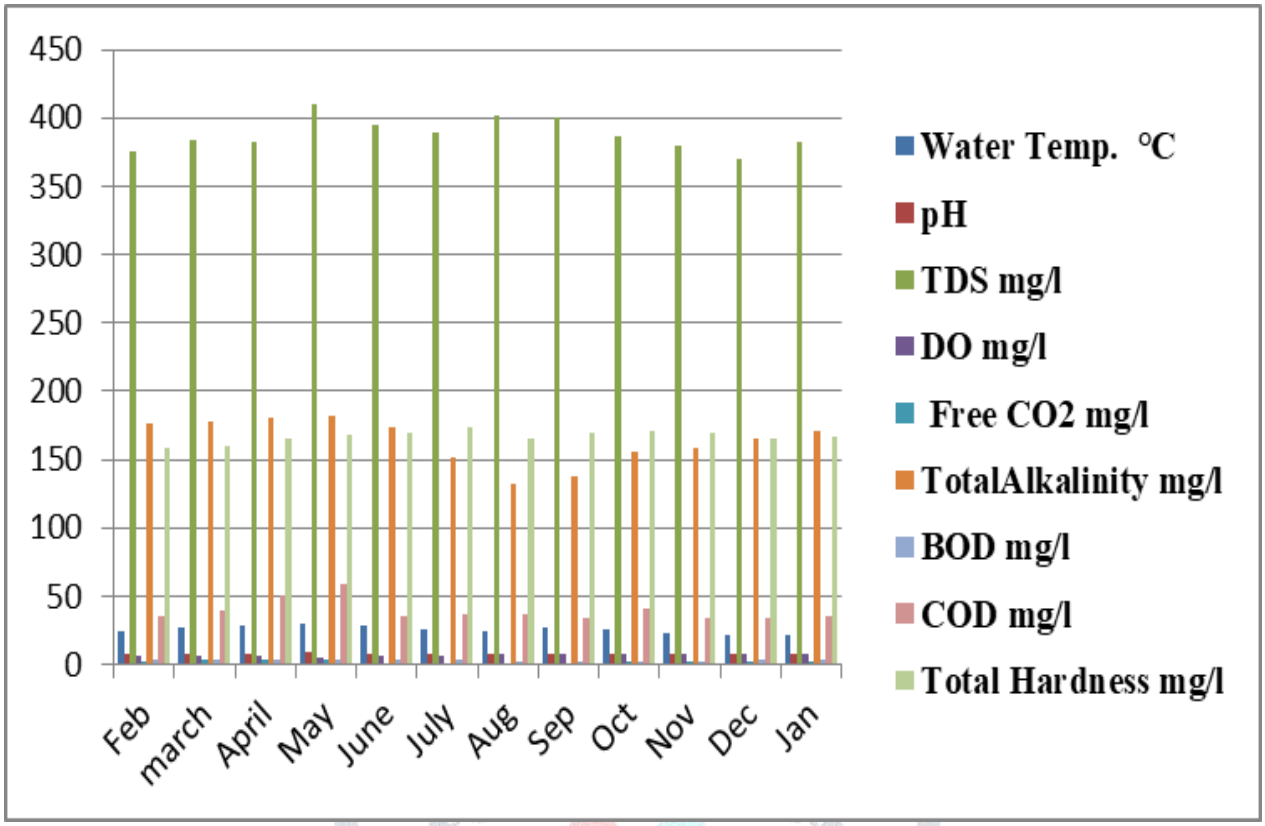

Fig.1. Dara Dam February 2017 to January 2018

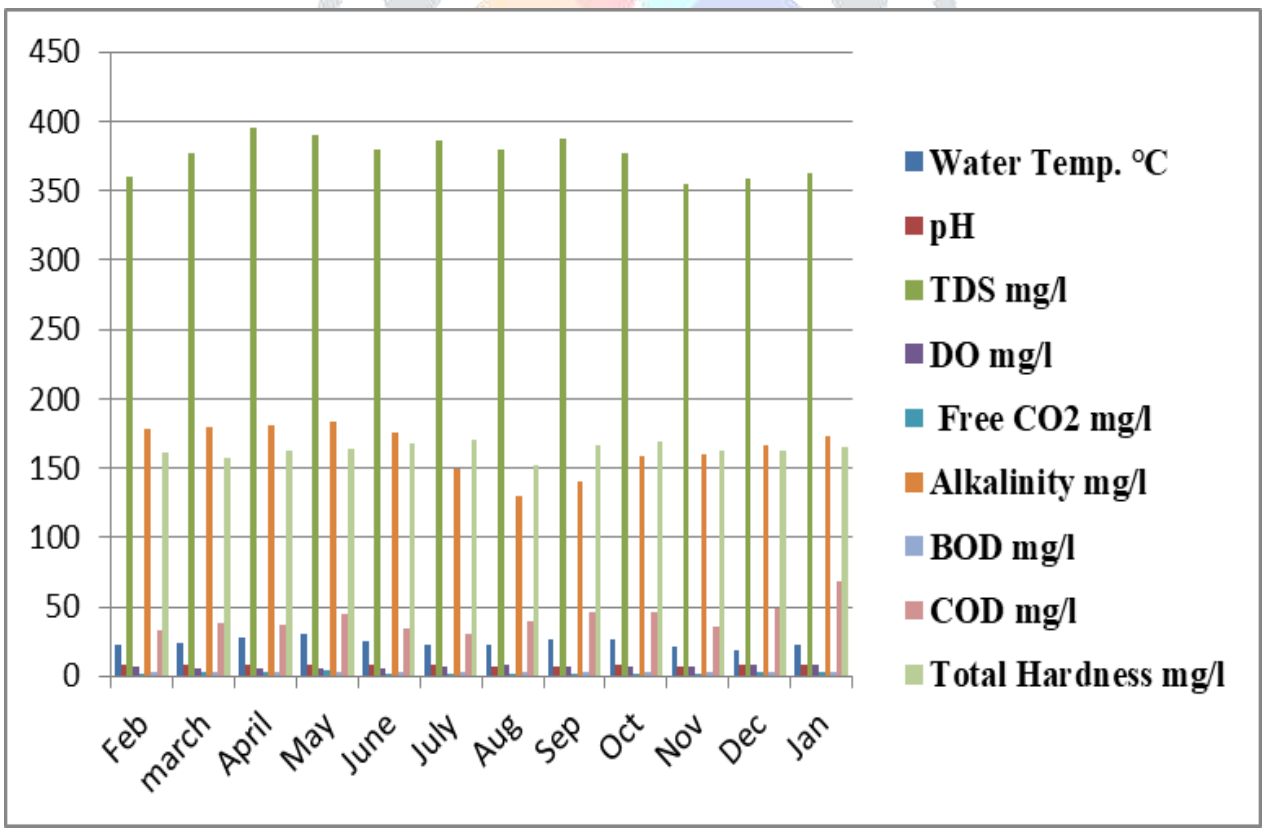

Fig.2. Dara Dam February 2018 to January 2019

All the Physico-chemical parameters were taken in mg/l except pH, TDS and temperature in °C.

Algal existence in the aquatic ecosystem cannot ever be considered alone, but algae are the main flora concerning prevailing environmental condition, particularly physicochemical parameters, e.g. in both lentic and lotic aquatic environments. The presence of algae could be a very useful indicator of water quality (Tiseer, F. A., Tanimu, Y., & Chia, A. M. 2010).

The study of physicochemical parameters co-related with the seasonal variations of algal diversity. The Chlorophyceae appears dominant over the Cyanophyceae throughout the study period. A similar result was made by Rani, P.P. & Rao, N. G. (2020).

The Physico-chemical parameter analysis was carried out in Dara dam from February 2017 to January 2019 for the analysis of water quality.

Temperature is may be the most broadly measured variable that affects algal growth. (Raven, J. A., & Geider, R. J. 1988).

In 2017 and 2018, the maximum temperature was recorded in May 30.20℃ and 30℃ recorded respectively. The minimum temperature recorded in December 2017 and 2018 was 21.30℃ and 19.20℃, respectively. It confirms the results of (Shinde, S. E. *et al.* 2010); (Manjare, S. A., Vhanalakar, S. A., & Muley, D. V. 2010).

Life is affected by the pH and by their processes. The habitat of the massed population of phytoplankton like wastewater treatment plants and eutrophic lakes mostly shows the effect of pH not only in day to day growth but also shows long duration changes very well (Dubinsky, Z., and Rotem, J. 1974).

In 2017, the maximum pH recorded in May was 8.40, and in 2018, in April, an 8.50 pH was recorded. The minimum pH that was recorded in July of 2017 was 7.30 and in 2018, it was 7.50 in August. The pH value is high during the summer season because of low water level and nutrient concentrations in water and during the monsoon, the pH values decrease because dilution occurs by rainwater (Shinde, S. E., *et al*. 2010), (Sawant, R., & Chavan, N. 2013). (Dhanam, S., Sathya, A., & Elayaraj, B. 2016).

The total dissolved solids of water are due to the small amount of organic and the main presence of inorganic salts in water like calcium, magnesium, potassium ion, sodium, calcium carbonate, chloride, sulfate etc.

The maximum TDS in 2017 in May was 410 mg/l and in 2018 in April it was 395 mg/l. The fluctuation was seen during the study period. The minimum TDS in 2017 was 370 mg/l in December, and in 2018 it was found to be 355 mg/l in November. A similar result was also obtained by Lubal, M. J., Sutar, A. U., & Pawar, K. W. (2012); Khune, C. J., Parwate, B. P. and Parshuramkar, B. B. (2020); Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009), who reported maximum TDS in the summer season.

Dissolve O_2 is not only an important factor for the quality of H_2O, but it also has great value for the aquatic living organism that lives in natural water (Wilcock, R. J., Stevenson, C. D., & Roberts, C. A. (1981).

During the testing, it was seen that there was a fluctuation in DO. The maximum DO was recorded 7.80 mg/l in January of 2017 and in August of 2018; it was 8.20 mg/l. In 2017, the minimum dissolved DO was 5.50 mg/l in May, and in 2018 in May it was 5.25 mg/l. The result displayed an opposite relationship with the temperature, which may be due to oxygen oxidation. Maximum DO in winter and minimum DO in summer were observed by Karne, A. V., & Kulkarni, P. D. (2009) and observed in the monsoon by Rajan, D. S., & Samuel, S. M. (2016).

Algae have the potential to fix atmospheric carbon dioxide, so it helps with the reduction of carbon dioxide levels in the atmosphere, which is considered a major worldwide issue (Singh, S. P., & Singh, P. 2014).

In the present study, the maximum free CO_2 was recorded in May throughout the study period. In 2017, it was 3.50 mg/l, and in 2018, it was 4.10 mg/l. In September of 2017, the minimum free CO_2 was 0.5 mg/l and in October of 2018, it was 1.0 mg/l. Conformity results were made by Bhagde, R. V., *et al.* (2020); Mahajan, V. S., & Pokale, S. S. (2017). The rise in free CO_2 can be due to an increased rate of decomposition during the dry season (Karne, A. V., & Kulkarni, P. D. 2009), or might be due to an increased rate of photosynthesis by the phytoplankton using CO_2 and providing O_2.

In algal culture medium, water-soluble salt CO_3^{2-} and HCO3- are the important sources of C (carbon) and most significant constituents of alkalinity (Zhang, Q., Wang, T., & Hong, Y. 2014).

In the present study, the maximum total alkalinity was recorded throughout the study period in May. In 2017, it was 182 mg/l and in 2018 it was 184 mg/l, respectively. During the study, the minimum alkalinity was recorded in August, throughout the study period. The recorded total alkalinity was 132 and 130 mg/l, respectively. The total alkalinity was found to be lowest in the monsoon because of the dilution of rainwater, and during the study, a maximum was found in the summer because of the evaporation of water. The conformity results were made by Agarwal, A. K., and Rajwar, G. S. (2010); and Ranjan, G., Singh, N. P., & Singh, R. B. (2007).

Biological oxygen demand represents the oxygen required for the decomposition of organic matter (More, R. R, and Ramaia, P. V., 2015).

Biological oxygen demand was recorded maximum during the present investigation in May throughout the study period. In 2017 and 2018, 3.40 mg/l and 3.50 mg/l were recorded, respectively. A minimum BOD was recorded in October throughout the study period. In 2017 and 2018, 2.20 mg/l and 2.40 mg/l were recorded, respectively. Hameed, I. O., *et al* (2019); Ray, J.G., Santhakumaran, P. & Kookal, S. (2020) also reported maximum BOD to occur in the dry season, and Agarwal, A. K., and Rajwar, G. S. (2010) reported minimum BOD in the winter months.

Chemical oxygen demand is an important Physico-chemical parameter and it denotes the determination of organic matter present in the water body (Kolb, M., Bahadir, M., & Teichgräber, B. 2017).

During the present study in both years, the maximum chemical oxygen demand recorded in May of 2018 was 58.4 mg/l and in 2019 it was 69 mg/l. In December 2017, the minimum COD was 33.50 mg/l recorded, and in July of 2018, the minimum COD was 30.20 mg/l. A similar result made by Meshram, U. G., Dahare, R. B., & Dhamani, A. A (2017); Thitame, S. N., & Pondhe, G. M. (2010) and Dubey, M., & Ujjania, N. C. (2013) reported maximum COD in the summer season.

The Ca (calcium) and Mg (magnesium), which mainly occur in water, cause the hardness of the water (United Utilities) and as per Worku, A., & Sahu, O. (2014). The hardness of water can be reduced by micro and macroalgal treatment.

In the present study, the maximum total hardness of water was recorded in July throughout the study period. In 2017, it was 173 mg/l and in 2018, it was 170 mg/l. Minimum hardness was recorded in February of 2017, was 158 mg/l, and in March of 2018, was 157 mg/l. The physico-chemical parameters were observed to be higher in reservoirs and lakes in the monsoon season than in the summer season (Makode. P. M. 2020).

Conclusion

The present investigation reveals that the water of the Dara dam is still in good condition because of fewer anthropogenic activities. The results of Physico-chemical parameters show that the studied water reservoir is suitable for algal growth and it is well diverse with Chlorophycean and Cyanophycean algal members.

Acknowledgment:

The authors are thankful to the Principal, Prof. Dr. V.S. Shrivastava and Head of the department of Botany Dr. B.B. Mangle, of G.T.P. College Nandurbar, for providing all the research facilities. We are also thankful to University Grand Commission for the financial support.

References:

1) Agarwal, A. K., & Rajwar, G. S. (2010). Physico-chemical and microbiological study of Tehri dam reservoir, Garhwal Himalaya, India. *Journal of American science*, *6*(6), 65-71.
2) Bhagde, R. V., Pingle, S. A., Bhoye, M. R., Pansambal, S. S., & Deshmukh, D. R. (2020). A Comparative Study of Physico-Chemical Parameters of the Freshwater Ponds from Sangamner Taluka of Ahmednagar, Maharashtra, India. *International Journal of Biological Innovations*, *2*(2), 137-142.
3) Bhaskar, K., Nautiyal, S., Khan, Y. I., & Rajanna, L. (2015). A preliminary study on Phytoplankton in Fresh water-Lake of Gogi, Yadgir district, Karnataka. *International Journal of Innovative Research in Science, Engineering and Technology*, *4*(4), 2030-2037.
4) Brayner, R., Couté, A., Livage, J., Perrette, C., & Sicard, C. (2011). Micro-algal biosensors. *Analytical and bioanalytical chemistry*, *401*(2), 581-597.
5) Carter, N. (1923). A Monograph of the British Desmidiaceae, Vol. *V. Ray Society, London*.
6) Chakdar, H., Jadhav, S. D., Dhar, D. W., & Pabbi, S. (2012). Potential applications of blue green algae.
7) Desikachary, T. V. (1959). *Cyanophyta* (Vol. 2). New Delhi: Indian council of agricultural research.
8) Dhanam, S., Sathya, A., & Elayaraj, B. (2016). Study of physico-chemical parameters and phytoplankton diversity of Ousteri Lake in Puducherry. *World Scientific News*, *54*, 153-164.

9) Dubey, M., & Ujjania, N. C. (2013). Water quality and pollution status of Tapi River, Gujarat, India. *International Journal of Pure and Applied Zoology*, *1*(3), 261-266.
10) Dubinsky, Z., & Rotem, J. (1974). Relations between algal populations and the pH of their media. *Oecologia*, *16*(1), 53-60.
11) Federation, W. E., & Aph Association. (2005). Standard methods for the examination of water and wastewater. *American Public Health Association (APHA): Washington, DC, USA*, *21*.
12) Gonzalves, E. A. (1981). Oedogoniales. ICAR New Delhi, 757 pp.
13) Happey-Wood, V. M. (1988). Ecology of freshwater planktonic green algae. *Growth and reproductive strategies of freshwater phytoplankton*, 175-226.
14) Iyengar, M.O.P. and Desikachary, T.V. (1981). Volvocales. ICAR Monograph on algae. Indian Council of Agricultural Research, New Delhi, India. Pp. 532.
15) Jain, N. (2015). Diversity of blue-green algae and study on related physico-chemical parameters of paddy fields of chhatarpur district of madhya pradesh International Journal of Research and Development in Pharmacy and Life Sciences, Vol. 4, No.2, pp 1456-1462.
16) Jyotsna, N., Subba Rangaiah, G., & Narasimha Rao, G. M. (2014). Seasonal variation of microalgae in relation to the physico-chemical parameters of Karagam Lake, Srikakulam District, AP India. *J. Algal Biomass Utln*, *5*(4), 68-73.
17) Karne, A. V., & Kulkarni, P. D. (2009). Studies on physico-chemical characteristics of freshwater bodies in Khatav tahsil, Maharashtra. *Nature, Environment and Pollution Technology*, *8*(2), 247-251.
18) Khune, C. J., Parwate, B. P. and Parshuramkar, B. B. (2020). Status of Phytoplankton in relation to Physico-Chemical characteristic of Siregaon Lake, Dist.Gondia (Maharashtra), India. *Int. Res. J. of Science & Engineering*, Special Issue A7: 367-371.
19) Kolb, M., Bahadir, M., & Teichgräber, B. (2017). Determination of chemical oxygen demand (COD) using an alternative wet chemical method free of mercury and dichromate. *Water research*, *122*, 645-654.
20) Lee, O.M. (2015). Algal Flora of Korea. Charophyta: Conjugatophyceae: Desmidiales: Desmidiaceae: *Cosmarium* II and *Staurastrum* II (Freshwater Green Algae). *National Institute of Biological Resources*, Volume 6, Number 7.
21) Lewis, L. A., & McCourt, R. M. (2004). Green algae and the origin of land plants. *American journal of botany*, *91*(10), 1535-1556.
22) Lubal, M. J., Sutar, A. U., & Pawar, K. W. (2012). Studies on Physico-chemical aspects of Mhaswad water reservoir of Satara District (Maharashtra) India. *International Journal of Plant, Animal and Environmental Sciences*, *2*(3), 12-15.
23) Mahajan, V. S., & Pokale, S. S. (2017). Studies on physico-chemical analysis of Mohabala lake near Bhadrawati, district Chandrapur (MS), India. *International Journal of Life Sciences*, *5*(3), 438-446.
24) Makode. P. M. (2020). Water quality analysis of Shivan irrigation dam Near Murtizapur, dist. Akola. *Int. Res. J. of Science & Engineering*, Special Issue (A7). 411-416.
25) Manjare, S. A., Vhanalakar, S. A., & Muley, D. V. (2010). Analysis of water quality using physicochemical parameters Tamdalge tank in Kolhapur district, Maharashtra. *International Journal of Advanced Biotechnology and Research*, *1*(2), 115-119.
26) Meshram, U. G., Dahare, R. B., & Dhamani, A. A 2017). Study on Physico-Chemical Parameters of Kurhada Lake at Pauni, Bhandara District, Maharashtra. *International Journal of Researches in Biosciences, Agriculture and Technology*, Special Issue 2 (5). 899-904.
27) More, R.R. and Ramaiah, P.V. (2015). Studies on Physico-Chemical Properties of the Water from Shivan Dam, Nandurbar Dist, Maharashtra, *Journal of Chemical, Biological and Physical Sciences JCBPS;* Section D; 2015 –Vol. (5). No. 2; 2062-2069.
28) Muigai, P. G., Shiundu, P. M., Mwaura, F. B., & Kamau, G. N. (2010). Correlation between dissolved oxygen and total dissolved solids and their role in the eutrophication of Nairobi dam, Kenya. *Int J Bio Chem Phys*, *18*, 38-46.
29) Parisara N, Narayana, J. and Puttaiah, E.T (2016). Diversity of blue-green algae in relation to physico- chemical parameter of konandur pond, thirthahalli taluk, Karnataka, International journal of current research, Vol. 8, Issue, 04, pp.29049-29054, April,.
30) Philipose, M. T. (1967) "Chlorococcales" I.C.A.R. Monographs on Algae, New Delhi, p. 365.

31) Pinder, A., & Hendry, K. (2007). ADDRESS: Haweswater House, Lingley Mere Business Park, Lingley Green Avenue, Great Sankey.
32) Rajan, D. S., & Samuel, S. M. (2016). Seasonal patterns and behaviour of water quality parameters of Achenkovil River. *International Journal of Fisheries and Aquatic Studies*, *4*(6), 489-494.
33) Ralfs, J. (1848). *The British Desmidieae*. London: Reeve, Benham & Reeve, King William Street, Strand.
34) Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. *E-Journal of chemistry*, *6*(2), 523-530.
35) Ramanathan, K. R. (1964) "Ulotrichales," ICAR, New Delhi, p. 188.
36) Ramanathan, K.R. (1959). Ulotrichales, Indian Council of Agricultural Research, New Delhi-
37) Randhawa, M. S. (1959). *Zygnemataceae*. Indian Council of Agricultural Research.
38) Randhawa, M. S., & Venkataraman, G. S. (1960). Notes on some Cladophorales from India. *Proceedings of the Indian National Science Academy-Part B: Biological Sciences*, *27*(2), 52-55.
39) Rani, P.P. & Rao, N. G. (2020). Seasonal distribution of microalgae in relation to hydrographical features of water streams at Punyagiri Hills, Vizianagaram district, Andhra Pradesh, India. J. Algal *Biomass Utln.* 11(1), 34-37.
40) Raven, J. A., & Richard J. Geider, R.J (1988). Temperature and algal growth. *New Phytologist*, 110 (4), 441-461.
41) Sakdeo, B. M. (2013). Relationship between physiochemical parameters and algal biodiversity of Bhima river Global journals of Bio-Science and Biotechnology G.J.B.B., VOL.2 (2), 227-229.
42) Sarojini, Y., Neelima, P., & Sujat, B. (2015). The seasonal variations in distribution of photosynthetic pigments in four edible species of Chlorophyceae and the effect of light, dissolved oxygen and nutrients on their distribution. *Annals Biological Research*, *6*(3), 36-40.
43) Sawant, R., & Chavan, N. (2013). Water Quality Status of Mahagaon Reservoir from Gadhinglaj Tahsil from Maharashtra. *International Journal of Science, Environment and Technology*, *2*(6), 1196-1204.
44) Scott, A.M. and G.W. Prescott. (1961). Indonesian desmids. Hydrobiologia 17(1-2):1-132.
45) Shinde, S. E., Pathan, T. S., Raut, K. S., More, P. R., & Sonawane, D. L. (2010). Seasonal variations in physico-chemical characteristics of Harsool-Savangi dam, District Aurangabad, India. *The Ecoscan*, *4*(1), 37-44.
46) Singh, S. P., & Singh, P. (2014). Effect of CO2 concentration on algal growth: a review. *Renewable and Sustainable Energy Reviews*, *38*, 172-179.
47) Thitame, S. N., & Pondhe, G. M. (2010). Assessment of seasonal variation in physico-chemical characteristics and quality of Pravara River water for irrigation use in Sangamner, Dist Ahmednagar, Maharashtra. *Journal of Chemical and Pharmaceutical Research*, *2*(2), 316-320.
48) Tiseer, F. A., Tanimu, Y., & Chia, A. M. (2010). Seasonal occurrence of algae and physicochemical parameters of Samaru stream, Zaria, Nigeria. *Asian journal of earth sciences*, *3*(1), 50-56.
49) Tiwari, A., & Chauhan, S. V. S. (2006). Seasonal phytoplanktonic diversity of Kitham lake, Agra. *Magnesium*, *7*(17.5), 8-5.
50) West, W., & West, G. S. (1904). *A monograph of the British Desmidiaceae* (Vol. 1).The Ray society.
51) West, W., & West, G. S. (1905). *A monograph of the British Desmidiaceae* (Vol. 2). The Ray society.
52) West, W., & West, G. S. (1908). *A monograph of the British Desmidiaceae* (Vol. 3). The Ray society.
53) West, W., & West, G. S. (1911). *A monograph of the British Desmidiaceae*. (Vol. 4) The Ray Society
54) Wilcock, R. J., Stevenson, C. D., & Roberts, C. A. (1981). An interlaboratory study of dissolved oxygen in water. *Water Research*, *15*(3), 321-325.
55) Worku, A., & Sahu, O. (2014). Reduction of heavy metal and hardness from ground water by algae. *J Appl Environ Microbiol*, *2*(3), 86-89.
56) Zhang, Q., Wang, T., & Hong, Y. (2014). Investigation of initial pH effects on growth of an oleaginous microalgae Chlorella sp. HQ for lipid production and nutrient uptake. *Water science and technology*, *70*(4), 712-719.