ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 03, pp.19461-19467, March, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

DIATOMS AS ECOLOGICAL INDICATORS OF WATER QUALITY ASSESSMENT IN ADIHALLI LAKE, GANDASI LAKE AND HALAGENALLI LAKES OF ARASIKERE TALUK, HASSAN DISTRICT, KARNATAKA, INDIA

[1]Purushotham, S.P. and *[2]Anupama, N.

[1]P.G. Department of Botany, Maharani's Science College for Women, Mysuru-570005, Karnataka, India
[2]Assistant Professor, Department of Botany, Maharani's Science College for Women, Mysuru-570005, Karnataka, India

ARTICLE INFO

Article History:
Received 12th December, 2017
Received in revised form
29th January, 2018
Accepted 19th February, 2018
Published online 30th March, 2018

Key Words:
Arasikere, Hassan,
Ecological indicators, Diatoms,
Organic pollution,
Anthropogenic pollution, water quality.

ABSTRACT

Ecological indicators have pervasive appeal to scientists, environmental managers and general public at large. They have long been used to detect changes in nature, but scientific maturation in indicator development has occurred mainly in the past twenty years. Currently, indicators are primarily used to assess condition of the environment, as early-warning signals of ecological problems. The present survey reveals the presence of diverse diatom communities in three lakes consisting of 9 different genera and 15 species. Anthropogenic activity was drastically increased in winter season in all the three lakes than in summer season. *Synedra ulna* (SULN) in Adihalli lake and *Navicula halophila* (NHAL) in Halagenahalli lake indicated the disturbances in lakes due to human activity and *Navicula mutica* (NMUT) considered as organic pollution indicators in polluted lakes. Highest number of 63,000 populations was found to be *Cocconeis placentula* (CPLA) in summer and 21,000 *Navicula arabica* (NARA) in winter of Adihalli lakes. In Gandasi lake summer season was predominated with *Actinocyclus ehrenbergii* (AEHR) with 42,000 and winter season with *Navicula rhynocephalia* (NRHY) with a population of 8,400. Similar size of population *Pinnularaia acrosphaeria* (PACR) of 42,000 in both winter and summer seasons was found in Halagenahalli Lake. Overall known diatoms are predicted as water quality indicators varied with their populations at winter and summer seasons.

Citation: Purushotham, S.P. and Anupama, N., 2018. "Diatoms as ecological indicators of water quality assessment in adihalli lake, gandasi lake and halagenalli lakes of Arasikere Taluk, Hassan District, Karnataka, India", *International Journal of Development Research*, 8, (03), 19461-19467.

INTRODUCTION

Lake ecosystems across the world are in distress due to deleterious effects of anthropogenic activities, and the threats to ecosystem health of lakes are likely to be amplified by the growing global climate change. There are imperative demands for holistic evaluation and restoration of these ecosystems. As such, bio monitoring techniques have become indispensible for the synergistic and integrated reflection of water quality assessment. Amongst various bio monitors recognized, the diatoms have served as one of the most robust and valuable indicators for the ecological assessment throughout the world. So far as India is concerned, most of the research work available with reference to diatoms is taxonomical and our ecological knowledge about these benthic indicators has just begun. Efforts are being made to bridge this gap. Unfortunately, eco-assessment with diatom based indices is evidently lacking in the Indian scenario. Bio-monitoring has been proven to be necessary and hence the importance of diatoms as ecological indicators of water quality has been stressed (Sawaiker and Rodrigues, 2017). Diatoms are ubiquitous, unicellular algae that form the basic bulk of planktonic population in the fresh water characterized by having a cell wall of silica. The wall consists of two valves that have more or less flat surface, held together by a girdle. Diatom from different region of India has been described by a various workers. Pascher (1930) described the large number of diatoms belonging to the central and pinnales group in his monograph "Die Sasswasserflora". Venkataraman (1956) gave a systematic account of South Indian Diatoms. Krishnamurthy (1952) made a contribution to the diatom flora of South India. Gonzalves and Gandhi (1953) have given a systematic account of the diatoms of the Bombay and Salsette. Gandhi (1961)

***Corresponding author:* Anupama, N.,**
Assistant Professor, Department of Botany, Maharani's Science College for Women, Mysuru-570005, Karnataka, India.

made extensive studies on the fresh water diatomaceae of India. Sarode and Kamat (1983) studied on fresh water diatoms of Vidarbha. Patil and Kumawat (2007) worked on the centric diatom of Abhora Dam, Jalgaon, Maharashtra. In India, many research papers have been published with respect to bio monitoring by plankton and macro invertebrates, yet the diatoms have been rarely used for bio assessment of major rivers Srivastava *et al*. (2016). But no work had been done on the diatoms of Adihalli lake, Gandasi lake and Halagenahalli lakes of Arsikere taluk, Hassan. Hence, the present study is an attempt to fill this gap. Most of the water quality monitoring research by using diatoms with physico-chemical parameters is done rather than the ecological parameter. Later on Van Dam *et al.* (1994) given another data are presented a literature about fresh water diatom taxa with ecological values. In the present study Van Dam software for monitoring diatoms as ecological indicators is used. This software has an inbuilt with the ecological data for about more than 10000-15000 diatom species along with complete name, reference, family type, sensibility, pH, salinity, indicators of organic pollution, oxygen requirement etc. At present three lakes of Arasikere Taluk of Hassan District, Karnataka, India is preferred, in this study for the water quality assessment as ecological indicators.

MATERIALS AND METHODS

Study Area

Karnataka is located 11^0 30' North and $18^0$30' North latitudes and 74^0 East and $78^0$30' East longitude. Hassan lying between 12°13′ and 13°33′ North latitudes and 75°33′ and 76°38′ East longitude, Hassan district has a total area of 6826.15 km². The Chikmaglur district is surrounded to the north west, Chitradurga to the north, Tumkur district to the east, Mandya district to the south east, Mysore district to the south, Kodagu to the south west and Dakshina Kannada district to the west. Hassan stands around 3,084 feet (940 m) above sea level.

Sampling

The sampling was made in the winter (October 2015) and summer (March 2016), water was sampled from three different lakes of Arasikere taluk i.e. Gandasi lake, Halagenahalli lake, and Adihalli lake. The sampling was made in the early morning from different lakes of Arasikere taluk by scrubbing the upper surface of water, the samples were collected from 1-2 feet depth. All these lakes are located in Arasikere surroundings with different distance and are used for many purposes i.e. domestic uses like bathing, washing and drinking for animals. Some of the lakes are used for fish culturing, fishermen got license from the department of fisheries. Different varieties of small fishes introduced into the lake in the month of June and July. They allow fishes to grow and after attaining specific size, they harvested and marketed either locally or outside places through the Department of fisheries. The following varieties of fish are reared in the lake are, Grass crap, Silver crap, Catla, Tilapia (julebi), *Labeo rohita* etc. These lakes also important for agricultural purposes, mainly for Coconut plantations and major crops like tomato, potato, ragi, maize etc. Satellite locations of all lakes are shown in Fig. 2

Assessment of water sample for indicator organisms

The samples were taken by adding 30ml of 4% formaldehyde for 1000 ml of each samples, about 10 ml of Lugol's Iodine solution is added to each sample in plastic bottles to sustain the color of organisms for the purpose of identification and it is kept for one day in undisturbed manner for sedimentation process. After sedimentation the supernatant is decanted and the remaining lower portion about 150 ml of the solution is transferred into a clean bottle and observed the samples under microscope (10X and 40X magnification).A drop of sedimented sample taken on a clean glass slide observed with the preferred magnification using microscope. The identified Diatoms are converted into Diatoms Per Liter (1 ml equals to 28 drops).

Photographs showing satellite maps of Arasikere taluk lakes, Hassan district

Fig. 1. Showing satellite maps of A) Adihalli lake B) Gandasi lake C) Halagenahalli lake

Photographs showing views and sampling site

Fig. 2. A) Adihalli lake; B) Gandasi lake; C) Halagenahalli lake

The recorded data was tabulated by using Van Dam software for monitoring diatoms as ecological indicators (Van Dam *et al*., 1994).

Taxonomic guidance

While analyzing the data to identify the organisms taxonomic guides consulted includes Hosmani *et al.* (2011) and Karthick *et al*. (2010). The eight lakes selected in the present study are Arasikere taluk lakes, here the diatoms are identified with subjected to Van Dam *et al*. (1994) software for obtaining the ecological condition of that lake.

Statistical analysis

The data of the present study were analyzed in the months of October (2015) to March (2016). The ecological conditions of the lakes with respect to present environmental conditions based on the data given by Van Dam *et al.* (1994) the diatoms were identified. Identification of diatoms was done with respect to their valves through the data given by Kelly (2002) and Hosmani (2002).

Van Dam software

Van Dam software for monitoring diatoms as ecological indicators is used.

This software has an inbuilt with the ecological data for about more than 10000-15000 diatom species along with complete name, reference, family type, sensibility, pH, salinity, indicators and percentage of organic pollution, oxygen requirement, saprobity, trophic state, moisture retention, indicators and percentage of anthropogenic indicators.

RESULTS

The above tables give the ecological data of the diatoms. This data was given by Van Dam, 1994. It includes the values of pH from 1-6, it indicates circumneutral, alkaliphilous, acidobiontic etc. Salinity is another ecological value it includes chloride content of the water sample or it may be fresh/ fresh brackish/ brackish etc. Nitrogen uptake metabolism includes the identified taxa are autotrophic (or) facultative (or) obligate. Moisture retention value includes depending upon the water bodies such as wet (or) dry. Trophic state is also one of the ecological values included under this software, here the organisms come under oligo, meso and eutrophic state were identified. Oxygen requirement is the other one it explains about the percentage of saturation. Saprobity is explains water quality class, oxygen saturation and Biological Oxygen Demand (BOD) is clearly illustrated. These ecological values are adapted to assess water quality of lakes of Arasikere Taluk, Hassan District.

Table 1. Showing sampling sites of 3 lakes

Lakes	Distance from Arsikere (km)	Longitude	lattitude	MSL (ft)	Shape	Size (acres)	Locat -ion	Storage Capacity (TMC)	Uses
1.Adihalli lake	27	76^0 18' 58''	13^0 79' 11''	2647	V shape	19.10	South	0.083	Domestic uses
2.Gandasi lake	18	76^0 22' 64''	13^0 68' 29''	2649	Star shape	150.50	South	0.295	Domestic uses
3. Halagenahalli lake	15	76^0 23' 68''	13^0 56' 25''	2651	Star shape	102.20	South	0.210	Agriculture, Domestic uses

Classification of ecological indicator values (Van Dam, Martens and Sinkeldam, 1994)

Table 2. To identify pH values

pH	Classes	pH Range
1	Acidobiontic	Optional occurrence at pH < 5.5
2	Acidophilous	Mainly occurring at pH < 7
3	Circumneutral	Mainly occurring at pH values about 7
4	Alkaliphilous	Mainly occurring at pH > 7
5	Alkalibiontic	Exclusively occurring at pH > 7
6	Indifferent	No apparent optimum

Table 3. To identify Salinity values

	Water	Cl^-(Mg l^{-1})	Salinity
1	Fresh	<100	<0.2
2	Fresh brackish	<500	<0.9
3	Brackish fresh	500-1000	0.9-1.8
4	Brackish	1000-5000	1.8-1.9

Table 4. To identify Nitrogen uptake metabolism (N) values

1	**Nitrogen-autotrophic taxa tolerating very small concentrations of organically bound nitrogen.**
2	Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen.
3	Facultative bound nitrogen-heterotrophic taxa needing periodically elevated concentrations of organically bound nitrogen.
4	Obligately nitrogen-heterotrophic taxa needing continuously elevated concentrations of organically bound nitrogen.

Table 5. To identify Moisture retention (M) values

1	**Never or only very rarely occurring outside water bodies**
2	Mainly occurring in water bodies, sometimes on wet places
3	Mainly occurring in water bodies also rather regularly on wet and moist places
4	Mainly occurring on wet and moist or temporarily dry places
5	Nearly exclusively occurring outside water bodies

Table 6. To identify Trophic (T) state

1	**Oligotrophic**
2	Oligo-mesotrophic
3	Mesotrophic
4	Meso-eutrophic
5	Eutrophic
6	Hypereutrophic
7	Oligo to eutrophic (Hypoeutraphentic)

Table 7. To identify Oxygen requirements (O) values

1	**Continuously high (about 100% saturation)**
2	Fairly high (above 75% saturation)
3	Moderate (about 50% saturation)
4	Low (above 30% saturation)
5	Very low (about 10% saturation)

Table 8. To identify Saprobity (S) values

	Saprobity	Water quality class	Oxygen saturation (%)	BOD 2O(mg l^{-1})
1	Oligosaprobous	I	>85	<2
2	β-mesosaprobous	II	70-85	2-4
3	α- mesosaprobous	III	25-70	4-13
4	α-meso-/polysaprobous	III-IV	10-25	13-22
5	Polysaprobous	IV	<10	>22

Diversity of diatoms in three different lakes

Fig: 3- A- ***Actinocyclus ehrenbergii*** **(AEHR); B-** ***Cocconeis placentula*****(CPLA) ; C-** ***Navicula arabica*** **(NARA)**

Table 9. Distribution of diatoms in Adihalli lake during winter (2015) and summer seasons (2016)

Diatoms in Adihalli lake	Winter	Summer
Achanthus exigua (AEXI)	8400	8400
Cocconeis placentula (CPLA)	4200	63000
Navicula arabica(NARA)	21000	0
Navicula rhynchocephala (NRHY)	8400	8400
Navicula similis (NSIM)	0	8400
Navicula sphaerophoria (NSPH)	12600	8400
Synedra ulna(SULN)	12600	16800

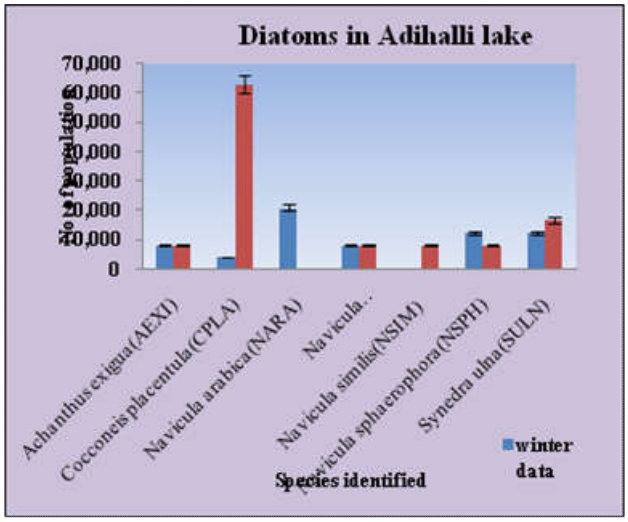

Fig 4- Graphical representation for distribution of diatoms in Adihalli lake during winter (2015) and summer seasons (2016)

Table 4. Distribution of Diatoms in Gandasi lake during winter (2015) and summer seasons (2016)

Diatoms in Gandasi lake	Winter	Summer
Actinocyclus ehrenbergii (AEHR)	0	42000
Cocconeis placentula (CPLA)	0	8400
Eunotia monodon (EMON)	0	4200
Navicula cari(NCAR)	8400	0
Navicula rhynocephalia(NRHY)	8400	8400

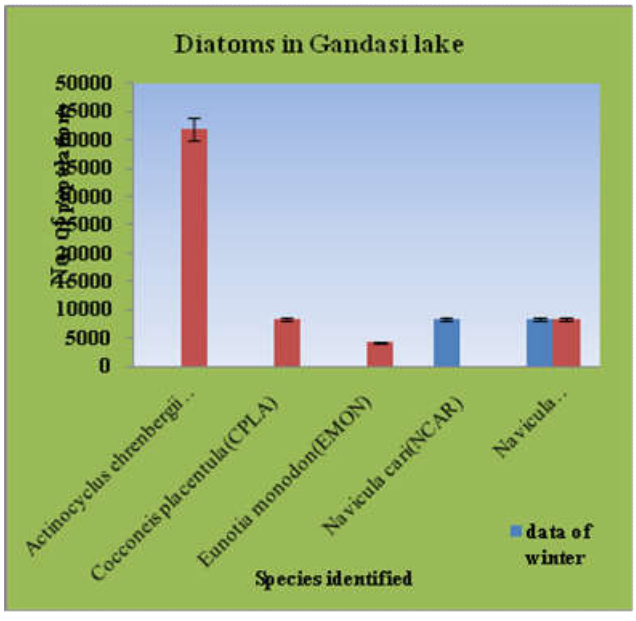

Fig 5. Graphical representation for distribution of diatoms in Gandasi lake during winter (2015) and summer seasons (2016)

Table 5. Distribution of Diatoms in Halagenahalli lake during winter (2015) and summer seasons (2016).

Diatoms in Halagenahalli lake	Winter	Summer
Fragilaria arcus (FARC)	4200	4200
Gyrosigma scalprosiles (GSCA)	0	4200
Navicula halophila (NHAL)	4200	4200
Navicula similis (NSIM)	21000	21000
Pinnularaia acrosphaeria (PACR)	42000	42000

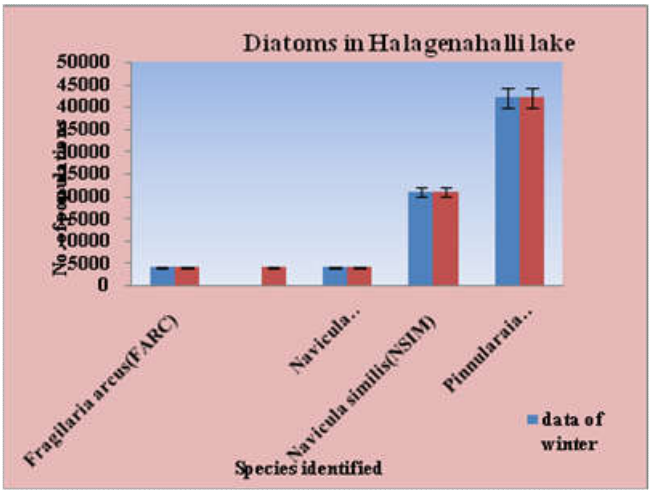

Fig 6. Graphical representation for distribution of diatoms in Halagenahalli lake during winter (2015) and summer seasons (2016)

DISCUSSION

Diatom indices are mainly used to discover the trophic and saprobic status of river/lakes/stream and also help to know the causes of stress and possible abatement, mitigation and control measures. The practice of having a comprehensive data base on the state of aquatic ecosystem is limited and as such no comprehensive diatom index exists for the Indian scenario. As indices developed in other eco regions should be tested before being applied in a basin that was never previously studied, major future efforts should be made in the direction of the development of a suitable diatom index (s) which would be specific to the eco region.

Water quality assessments based on the use of diatoms are now well developed and their value is predicted in international level. Diatom assemblages support paleo ecological investigations, historical reconstruction of water quality and the determination of prevailing water quality conditions. Diatoms provide a fine level of diagnostic resolution of the causes underline the change in water quality and environmental condition. (Harding *et al.,* 2005), diatoms were considered as biomonitoring tool; analysis of the lake sample predicts diatoms are useful in providing an indication of the ecological condition (Taylor *et al.,* 2007). Usually diatoms are widely used in stream bio assessment due their broad distribution, extraordinary variability and the ability to integrate changes in water quality, here also it confirms that diatoms are sensitive to organic and nutrient contamination and revealed the importance of suspended solids (Maria *et al.,* 2009). Increasing anthropogenic influence on lotic environments as a result of civilization as captured public interest because of the consequent problems associated with deterioration of water quality. Diatoms are extensively used for monitoring of water quality (Bere *et al.,* 2010), seasonal variation of diatoms density and species richness was studied,

they are not only for fishery management but also are the biological indicators of pollution. (Kumar, 2015). In the present study the different types of diatoms were identified in three lakes about 9 genera and 15 species were recorded which is in accordance with similar work of Narayan and Barupal, 2015. Our studies are in agreement with group works of water quality assessment by Kelly (2002), Van Dam (1994), Bellinger (2006), Taylor (2007), Basavarajappa *et al*. (2011), Hosmani (2012), Bere (2014), Kumar (2015) and Narayan *et al*. (2015) etc. The Van Dam *et al*. (1994) software serves as an important role in determining the ecological status of the water body, diatoms are the major ecological indicators of water quality and also indicate pH, salinity, nitrogen uptake metabolism, oxygen requirement, saprobity, trophic state, moisture retention, diatom index, percentage and indicators of organic pollution, percentage and indicators of anthropogenic eutrophication of each lake is determined in this investigation. Our results are in concurrence with diatoms structure which depends on variety of environmental factors that include biological parameters as well as physic-chemical parameters (Patil *et al.,* 2013). The ecological values of three lakes are differed from lake to lake. The pH range in Adihalli lake, Gandasi lake, Halagenahalli lake differed with seasons. The pH value depends upon the presence of species in that particular lake, the lakes studied are fresh brackish and fresh water, chloride content is less than 500 and salinity is less. As same to salinity all the lakes includes nitrogen tolerating autotrophic species and also moisture tolerance in species occurring mainly on water bodies but in some cases they are found on wet places and rather regularly on wet and moist places. Index of diatom saprobic eutrophication values were different in all the three lakes, in Adihalli lake- 3.12%, Gandasi lake- 3.45%, Halagenahalli lake- 4.21% in winter season and in case of summer season in Adihalli lake- 3.10%, Gandasi lake- 3.30%. Anthropogenic eutrophication was also found except in Halagenahalli lake. In case of Adihalli lake about 31.25% - 22.22%, in Gandasi lake 50% - 33.33%, corresponding values for percentage of winter-summer seasons of anthropogenic eutrophication. High eutrophication was observed in Gandasi lake.

Conclusion

Robust biological indicators, such as the diatoms, that can be indicative of specific water quality variables and state the actual "health" and ecological status of lake ecosystems of India is the need of the hour. The interpretation in terms of impact severity would immensely help to establish priorities for pollution control efforts in our country. The results obtained from our pilot study of ongoing research provide and reveals the presence of different diatom communities in the studied lakes. Anthropogenic activity has drastically increased in winter season in at Adihalli lake, Gandasi lake, Halagenahalli lake, than the in summer season, they strongly influence the water quality such as pH, color, taste and odour, because of pesticides and fertilizers used by agriculturists and also by domestic wastes in the surrounding area. In *Synedra ulna* (SULN) and *Navicvula rhynocephula* (NRHY) are considered as a most common anthropogenic eutrophication indicator and also *Naviula halophila* (NHAL) in Halagenahalli lake indicating organic pollution. This study confirmed that diatoms are an important bio indicators for assessing ecological quality of the lakes studied with respect to organic pollution and anthropogenic eutrophication. If care is not taken to these lakes they get severely polluted in future and may cause lots of deadly diseases to humans as well as animals and also decrease crop yield.

Acknowledgement

The authors are thankful to the PG Department of Botany and the Principal of Maharani's Science College for Women, Mysuru, Karnataka, India for providing necessary facilities.

Conflict of Interest: Declared None

REFERENCES

Basavarajappa, SH., Raju, NS., Hosamani, SP. and Niranjana SR. 2011. Fresh water diatoms as indicators of water quality of some important lakes of Mysore, Karnataka, India *Indian Hydrobiology,* 14: 42-52.

Bere, T. and Tundisi, JC. 2010. Diatom-based water quality assessment in streams influence by urban pollution:effects of natural and two selected artificial substrates,sao carlos-sp, Brezil. *Brazilian Journal of Aquatic Science and Technology*, 15:54-63.

Bere, T., Mangadze, T. and Mvedzi T. 2014. The application and testing of diatom-based indices of stream water quality in Chinhoyi Town, Zimbabwe**.** 40:503-512.

Gonzalves, EA. and Gandhi, HP. 1952. A systematic account of the Diatoms of Bombay and Salsette. I. *International Journal of Indian Botanical Society,* 31: 117-151.

Harding, WR., Archibald, CGM. and Taylor, JC. 2005. The relevance of diatoms for water quality assessment in South Africa: *A position paper* 31: 41-46.

Hosmani, SP. 2012. Application of benthic diatom community in lake water quality monitoring. *Online International Interdisciplinary Journal*, 2:21-34.

Karthick, B., Taylor, JC., Mahesh, MK. and Ramachandra, TV. 2010. Protocols for collection, preservation and enumeration of diatoms from aquatic habitats for water quality monitoring in India. *Journal of Soil and Water Sciences,* 3:25-60.

Kelly, M.G. 2002. Role of benthic diatoms in the implementation of the urban waste water treatment directive in the river wear, North-East England. *Journal of Applied Phycology*, 14: 9-18.

Krishnamurthy, V. 1952. A contribution to the diatom flora of South India. *Journal of Indian Botanical Society,* 33:354-381

Kumar, A. 2015. Studies on diversity and abundance of fresh water diatoms as indicators of water quality in Glacial fed Goriganga River, India. *International research journal of environmental sciences,* 4:80-85.

Maria, J.F. and Salome, FP., Almeida, Sandra, C. and Calando AJ. 2009. A comparison between biotic indices and predictive models in stream water quality assessment based on benthic diatom communities. *Ecological indicators,* 9:497-507.

Narayan, P. and Barupal, GK. 2015. A systematic account of the fresh water diatoms from kaylana lake of Jhodhpur district, Rajasthan, India. *International journal of Recent Scientific Research* 6:3435-3439.

Pascher, A. 1930. Die Sussawasser flora (Diatomeae). Volume-10. Jena Verlag von Gustav Fischer.

Patil, SB. and Kumawat, DA. 2007. Studies on the centric diatoms from Abhora dame of Jalgaon District, Maharashtra. *Research link*, 359:154-155.

Patil, JV., Ekhande, AP. and Padate, GS. 2013. Water quality monitoring - study of seasonal variation of diatoms and

their correlation with physicochemical parameters of Lotus Lake, Toran mal (M.S) India. *Archives of applied science research*, 5:172-176.

Sarode, PT. and Kamat, ND. 1983. The Diatom flora of Vidarbha, India I. *Bibliotheca Phycologica. J. Cramer*, 66:259-319.

Sawaiker, RU. and Rodrigues, BF. 2017. Biomonitoring of selected fresh water bodies using diatoms as ecological indicators, *Journal of Ecosystems & Ecography* 7:1-6.

Srivastava, P., Verma, J., Grover, S. and Sardar, A. 2016. On the importance of diatoms as ecological indicators of river ecosystem: A review. 5:70-86.

Taylor, J.C., Harding, W.R. and Archibald, C .G .M. 2007. An illustrated guide to common Diatom species from South Africa. WRL Report TT 282.

Van Dam, H., Martens, A. and Sinkel Dam, J. 1994. A coded checklist and ecological indicator values of fresh water diatoms from the Netherlands. *Netherland journal of Aquatic ecology*, 28:117-133.

Venkataraman, G. 1956. Contribution to our knowledge of freshwater Diatoms of South India. Govt. Press, Madras, pp-20.

****