Eco. Env. & Cons. 28 (May Suppl. Issue) : 2022; pp. (S389-S394)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03s.055

A detailed study of diatoms a Bacillariophyta community from Rewalsar and Prashar lakes of Himachal Pradesh, their bio-monitoring characteristics and forensic significance

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(Received 23 October, 2021; Accepted 8 November, 2021)

ABSTRACT

Diatoms are ubiquitous, unicellular, siliceous walled, aquatic, autotrophic in nature and a part of Bacillariophyceae class of algae. Diatoms are ecologically very much helpful. They act as a very good bio-monitoring agents. Their sensitive character towards the environmental factors makes them a monitor. Diatoms shows their affect towards temperature, chloride content, Ammonia and Biochemical oxygen demand quantity. The species are studied from water samples of Rewalsar and Prashar lakes of Himachal Pradesh. Diatoms are utilized by forensic investigators in solving the drowning cases occurred due to accidental or by suicidal modes. So these diatoms are very significant even with forensic angle .

Key words : *Diatoms, Unicellular, Ecology, Factors, Forensic.*

Introduction

Bacillariophyceae class community diatoms are ecologically aquatic and microscopic in nature. They contribute and produce 25% of atmospheric oxygen. Diatoms are autotrophic, produce food photosynthetically (Karthik *et al*., 2013). They are very important part of aquatic food chain both in fresh and marine water (Cox, 1996). Riato *et al*., (2017) described about the sensitivity of life forms in different seasons on wetlands. They studied low and high profile ecological disturbances. Diatoms act as a functional group in the bioassessment of wetland life forms. Hlubikova *et al*., (2007) evaluated Slovak rivers ecological condition by analyzing environmental variables. Mentioned the applications of thirteen diatom species. Blanco *et al*., (2012) compared diatom diversity with environmental variable through different statistical method and techniques. Stevenson *et al*., (2010) diatom assemblage responds to the sensitivity of streams and river ecological change. Dalu *et al*., (2016), 112 diatom species belonging to 36 genera were identified. The variation of diatom species explained along with ammonium, nitrate, conductivity, pH, temperature, resistivity and water flow factors. Different analytical tools like

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OMNIDIA, BIWQ etc. were used. Cibic *et al*. (2012) studied the disturbance effect on ecosystem by the response of benthic diatoms. They found Nitzschia and Navicula give positive response with increasing temperature. Pleurosigma, Diploneis give negative response with increasing temperature. Suphan *et al*. (2012) explained the role of benthic diatoms in assessing water quality of Mekong river. Battarbee *et al*. (2002) diatomist now focused on diatom-environment relationships for diagnosing the ecological changes. Stevenson *et al*., (2008) analyzed environmental conditions of streams on the basis of benthic diatom composition. Rioual *et al*., (2013) focused on the biomonitoring of lakes and rivers on the basis of diatoms. Li *et al*., (2010) showed relationship between diatoms and hydrochemical variables in lakes of Badain Desert, China. Lobo *et al*., (2016) identified the water quality of streams and rivers by studying the tolerance of diatoms towards pH, conductivity, salinity, humidity, oxygen requirement, velocity etc. Harding *et al*. (2014) use diatoms for determining the historical condition of Jukskei river catchment, Gauteng Province, South Africa. Lotter *et al*., (1997), they relate total phosphorus concentration with diatoms data. Cvetkoska *et al*., (2018), studied how environment affect and shapes diatom diversity in lake Ohrid. McQuoid *et al*., (2003) explained the role of *Paralia sulcata* as a paleo indicator species. Saros *et al*. (2014) studied the role of Cyclotella species as a palimnological indicator. Harding *et al*., (2005) used diatoms as water quality assessment protocol. Gevrey *et al*., (2004) self-organizing maps and back propagation learning algorithm used for water quality assessment through diatoms. Mangadze *et al*. (2019) analyze water quality of Blonkrans river system, South Africa on the basis of diatoms. Shen *et al*. (2019) compare false – positive cases and true drowning cases. They studied 64 victim cases and conform 32 cases died due to drowning. Li *et al*., (2020) diagnose drowning cases by evaluating the value of diatom types, their patterns in organs and water samples. Liu *et al*., (2020) differentiate drowned or murdered then dumped body on the basis of morphological and molecular characterization of diatoms. Zhao *et al*. (2019) analyzed diatoms in lung tissues, liver tissues and kidney tissues from drowning death cases. Zhou *et al*. (2020) reviewed about the diatom testing in past decades for determining the drowning deaths. Levin *et al*. (2020) did crime reconstruction through quartz grains and diatom valves.

Materials and Methods

Samples were collected from two lakes Rewalsar and Prashar of district Mandi, Himachal Pradesh. They lie on altitude of 1360 m to 2730 m i.e. Rewalsar lake (Location 1) lie on 1360 m from sea level and Prashar lake (Location 2) lie on 2730 m from sea level. They are mainly lie in Dhauladhar ranges of Himalaya.

Samples were collected in sterilized glass bottles of 500 ml. Total five samples, each collected randomly from a particular location. Then take 5ml sample from each solution and make five test tubes of each. Then add 5ml distilled water to it. Centrifuge it for ten minutes at 4000 rpm. Remove the su-

Location 1. A view of Rewalsar lake during sample collection.

Location 2. A view of Prashar lake during sample collection.

pernatant. Then add 1 ml 20% H_2O_2 solution in it. Centrifuge the soln. again and discard the supernatant. Add 2-3 drops of a stain which is a mixture of Aniline blue (0.1% aqueous), Fast green (0.5 % aqueous) for permanent staining. Then mount the slide permanently with 10% glycerine. Finally observe diatoms under microscope.

Result

Water samples were collected in two seasons summer (May-June) and winter (November-December) of 2018 – 2019 period. During the physiochemical analysis of water samples Rewalsar lake (Location 1) and Prashar lake (Location 2) the level of average temperature, average chloride, average ammonia and average B.O.D level is so much high as compared to Prashar lake. The whole detail of factor analysis is shown in Table 1. Rewalsar lake water sample shows no diatom species. Prashar lake water sample showed fifteen diatom species found in it. The fifteen diatom species are *Nitzschia angustata, Cymbella kolbei, Nitzschia levidensis, Nitzschia recta, Navicula arenaria Donkin, Navicula trivialis Lange, Navicula gregaria Donkin, Cymbella turgidula Grunow, Gomphonema minutum Agardh, Gomphonema affine, Diatoma tenuis, Fragilaria ulna, Encyonopsis budelii Krammer, Navicula cancellata Donkin, Fragilaria rumpens*. Also mentioned in Table 2 and 3. A graphical diagram in Figure 1, bar chart in Figure 2 and

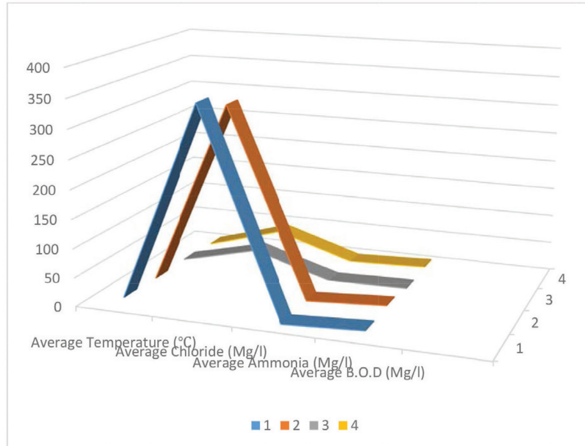


Fig. 1. A graphical representation of physiochemical factor analysis of both Prashar and Rewalsar lakes water samples.

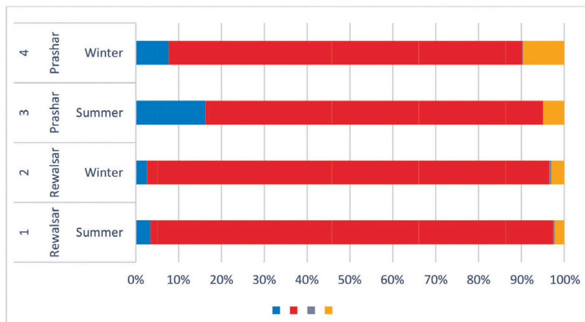


Fig. 2. A bar chart representing different percentage of physiochemical factors during analysis of water samples of both Prashar and Rewalsar lakes.

Table 1. Representing the study of physiochemical factor analysis of both Rewalsar and Prashar lakes.

Sr. No.	Location	Season	Average Temperature (°C)	Average Chloride (mg/l)	Average Ammonia (mg/l)	Average B.O.D. (m1g/l)
1.	Rewalsar	Summer	12.5	350.2	1.0	8.3
2.	Rewalsar	Winter	9.0	325.8	1.5	10.4
3.	Prashar	Summer	8.3	40.2	0.008	2.5
4.	Prashar	Winter	4.0	43.1	0.09	5.0

Table 2. Showing diatom species found in both Rewalsar and Prashar lakes.

Sr. No.	Location	Season	Common Diatom Species
1.	Rewalsar	Summer	No species found
2.	Rewalsar	Summer	
3.	Prashar	Winter	*Nitzschia angustata, Cymbella kolbei, Nitzschia levidensis, Nitzschia recta, Navicula arenaria Donkin, Navicula trivialis Lange, Navicula gregaria Donkin, Cymbella turgidula Grunow, Gomphonema minutum Agardh, Gomphonema affine, Diatoma tenuis, Fragilaria ulna, Encyonopsis budelii Krammer, Navicula cancellata Donkin, Fragilaria rumpens.*
4.	Prashar	Winter	

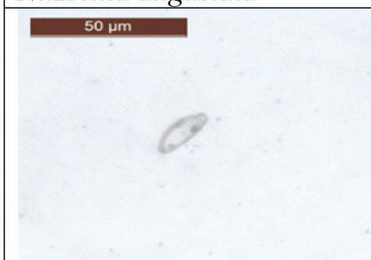
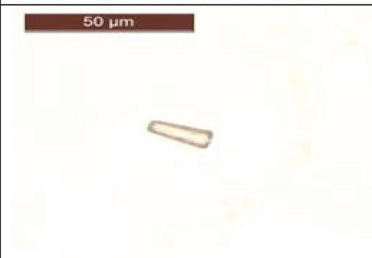
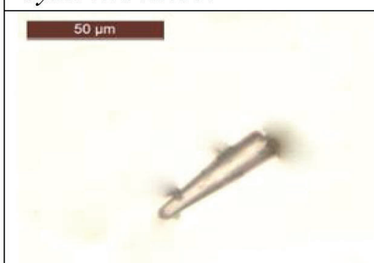
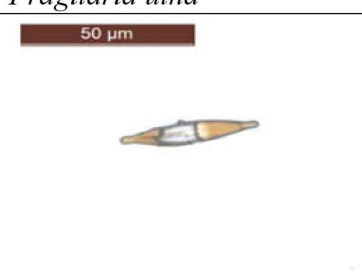
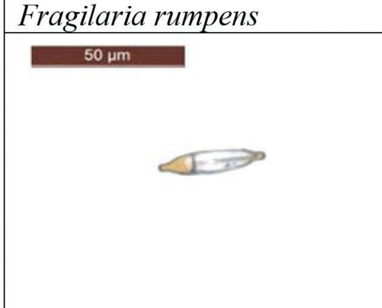
		
Nitzschia angustata	*Cymbella turgidula Grunow*	*Navicula arenaria Donkin*
		
Cymbella kolbei	*Diatoma tenuis*	*Gomphonema minutum Agardh*
		
Gomphonema affine	*Fragilaria ulna*	*Navicula trivialis Lange*
		
Fragilaria rumpens	*Navicula gregaria Donkin*	*Nitzschia recta*
		
Nitzschia levidensis	*Navicula cancellata Donkin*	*Encyonopsis budelii Krammer*

Table 3. A detailed microscopic view of diatom species along with scale from the water body of Prashar lake.

two pie chart comparison diagrams are shown in Figure 3 and 4. This indicates the physiochemical factors analysis and their quantity index. The presence of fifteen species in the water samples of Prashar lake and absence of diatoms in Rewalsar lake sample helps the forensic experts in solving the drowning death mysteries occurred in future in particular season. Also physiochemical concentration studies helps the forensic experts in identifying whether there in any chance of the presence of diatom species or not. If pollution rate is high in water and absence of diatoms occurred then forensic experts can also include other factors like bio-monitoring of physiochemical factors into their investigations further.

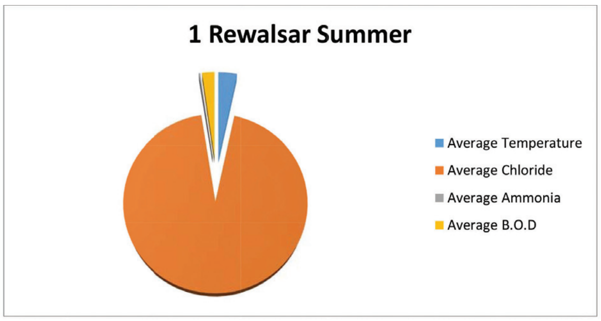


Fig. 3. A pie chart showing maximum effect of factor Chloride in summer period of Rewalsar lake.

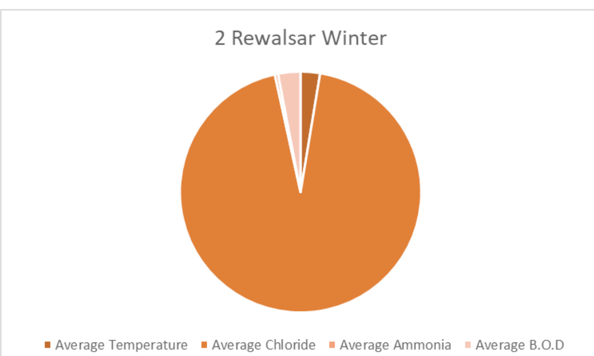


Fig. 4. A pie chart showing maximum effect of factor Chloride in summer period of Rewalsar lake.

Conclusion

The whole study shows the presence of maximum iatom species only in the water body where level of temperature, chloride, ammonia, B.O.D (Biochemical oxygen demand) is very low in both summer and winter seasons. Rewalsar lake water is much more polluted as compared to Prashar lake. The Chloride, Ammonia content and B.O.D level of Rewalsar lake is quite high as compared to Prashar lake. Prashar lake is much undisturbed as compared to Rewalsar lake. Hence physiochemical factors will effect diatom species very much. Prashar lake shows the the presence of fifteen diatom species (Table 1) while Rewalsar lake shows negligible diatom species. The sensitivity of diatom species towards physiochemical factors shows their bio-monitoring characteristics. The identified diatom species help in solving accidental or non-accidental drowning deaths. This boosts the forensic investigation.

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