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# AN INVESTIGATION ON BIODIVERSITY OF AQUATIC INSECTS IN SAGAR LAKE IN INDIA

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**Abstract:**

Sagar Lake is located in the centre of Sagar city in Madhya Pradesh. This lake is surrounded by agricultural fields, industries, hospital, bus stand and slums. The waste from the industries and surrounding localities is directly discarded into the lake. To evaluate the water quality of this lake, study was carried out for the period of two year from July 2013 to June 2015. Monthly water samples and aquatic insects were collected to analyse different physico-chemical parameters and diversity indices. The status of lake was investigated on the basis of obtained results of physico-chemical parameters of water and diversity indices of aquatic entomofauna. Keywords: Sagar Lake, industries, localities, water samples, physico-chemical parameters, water quality, aquatic entomofauna

## Introduction:

Biodiversity includes species variation, ecosystem variation and genetic variation in a particular environment while aquatic biodiversity includes the variety of life within aquatic ecosystem. According to Tachet et al. (2003) [18] aquatic water bodies are under various kind of stress caused by anthropogenic activities. This situation threatens both aquatic living resources and human population Ramade (2002) [15] . Biodiversity loss in freshwater ecosystems is an increasing phenomenon mainly due to human activities Abell (2002) [15] . Insects are habitat specialists as they are present in some extent nearly in every single type of habitat and are frequently good indicators Ganai (2011) [24] , Lewis and Gripenberg (2008) [13] . Removal or loss of aquatic insects can cause negative effects in the eco-systems stability and diversity Krishnan et al. (1988) [12] . Standard physico-chemical water quality methods are carried out in conjunction with biomonitoring tools to comprehensively evaluate the health of freshwater ecosystems Subramanian and Sivaramakrishnan (2007).

Sagar city is situated around a huge lake called 'Lakha Banjara' or 'Sagar Lake'. Organic matters including suspended solids and nutrients connect the lake through drainage system. Sagar Lake is also a significant area for the anthropologic activities like bathing, boating, washing clothes and entertainment etc. as it is situated at the center of the city. In this way contamination of Sagar Lake is due to arrival of waste water and human actions which displays high level of biological wastes leading for deterioration of water quality, high productivity and decline biological diversity. Due to insufficient studies on limnological characteristics of Sagar

Lake and aquatic insects an inclusive study was made to evaluate the current state of water quality. In this paper an attempt has been made to understand how sensitive and tolerant species of aquatic insects reflect status of water quality of Sagar Lake which receives many effluents from different sources.

## Materials and Methods

### Study Area

Study was conducted in Sagar Lake which extends over an area about 400 acres. Sagar Lake is located at the centre of Sagar city with a range of 82 hectares (23° 50 Minutes N: 78° 45 Minutes E and 517 MSL). The Lake has periphery of 5230 m with maximum length 1247 m, width 120 m. Mean depth of the Lake is 2.48 m with maximum depth of 5.3 m at full tank level. According to Mishra (1969) [14] Sagar Lake is a shallow rained lake with a small catchment area of 588 hectares and commonly organized by north westward drainage arrangement of district. The lake is popularly known as "Lakha Banjara" is divided into two parts, the main lake with spread area of 1.1848 ha. and small wetland with water spread area of 0.4046 ha. The catchment area of the lake basin is 1817 ha. out of which the total water spread area is 145 ha.The main lake is well protected by a large number of ghats, houses, roads and a stone fencing wall all around, except on the southern open side which ultimately terminates in the small wetland which is connected to the main lake by a narrow passage through the earthen bound.

Sites selection for samples collection In the present investigation a survey of physico-chemical parameters and aquatic entomofauna of the lake were studied for two calendar years from 2013 to 2015. Eight sites were selected for the present study, four sites from main lake and four from small wetland, which are given below :-

1. Dhobi Ghat 2. Brindavan Bagh Nalla 3. Ganga Mandir 4. Mahalwar Mandir 5. Kanera Feeder Canal 6. Baghraj Canal 7. Fisheries Department 8. Khari Nala

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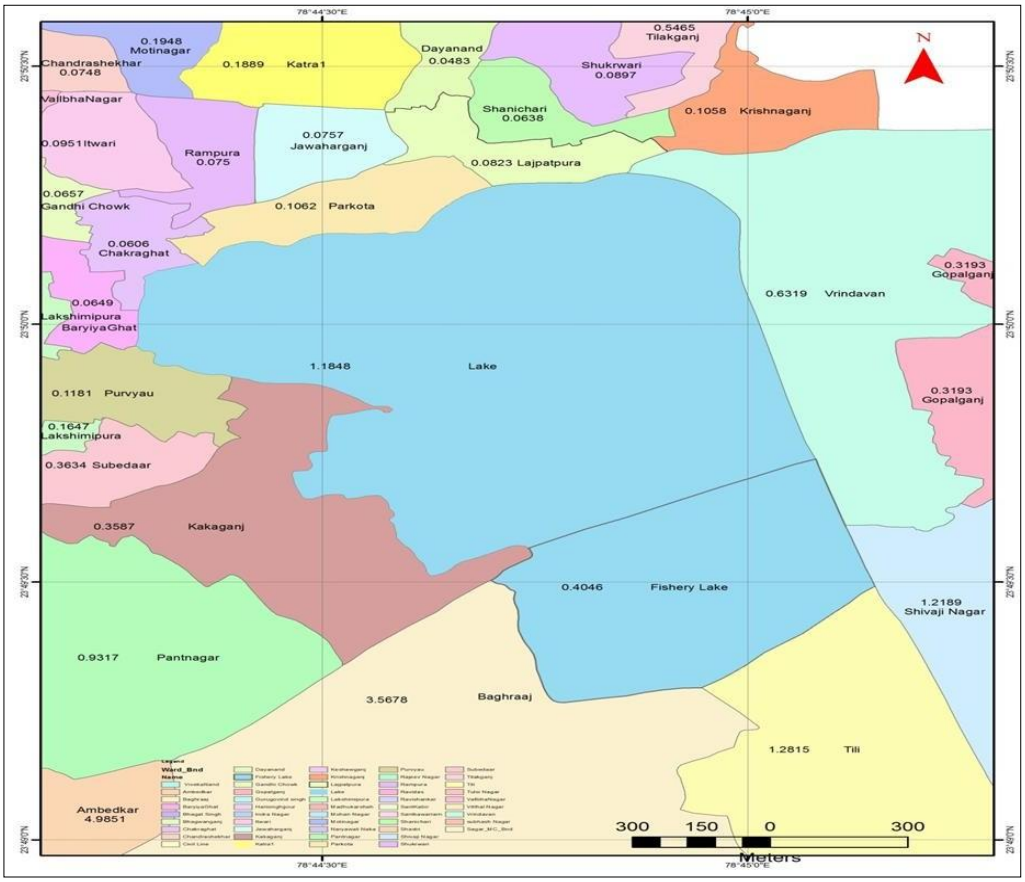


## Physico-chemical parameter

Monthly water samples were collected and brought to the laboratory for water analysis in three replications for each test, sampling was done in 3rd week of every month at 8 am to 10 am from each site of the lake. The water parameters were analysed by the methods adopted by Trivedy and Goel (1984) [19] and APHA (2005) [3] . The water parameters like TDS, Transparency, Temperature, pH and DO were performed at the site, while the rest of the parameters namely COD, BOD, Total Alkalinity, Total Hardness, Chloride, Phosphate and Nitrate were analysed in the laboratory using titrimetric method.

## Biological parameters

Samples were taken from four corners of each part of lake i.e. main lake and small wetland within an area of 10m² in three replications. Insect collection was made by dipping and dragging method by a pond net made up of finely meshed polyester mosquito curtain cloth of 1mm mesh size. Insects were randomly collected and preserved in 70% ethyl alcohol at sites. The specimen were preserved in glass jar or in polythene bags by the method adopted after Subha Rao (1989). All the samples of the insects were bought to the laboratory for sorting,

counting and identification. In the laboratory insects were identified up to lowest taxonomic level. Dissecting microscope or a compound microscope was used to identify the minor insects. Identification of the insects samples were done by using standard keys. Identification of species was confirmed in the laboratory of Zoological Survey of India, Jabalpur (M. P.).

**Diversity Indices**

It was calculated by following methods

(a) Shanon Diversity Index (H): The value of index ranges from 0 to 5. The value above 3 indicate balanced and stable habitat, while value below 1 indicates

pollution and habitat destruction. Species diversity of aquatic insects was determined by Shannon-Wiener's Index using the formula: H= -Σ pi ln pi Where; Pi= n/N H= Shanon diversity index n= Number individuals belonging to i species N=Total number of individuals (b) Simpson Index (D): The value of index ranges from 0 to 1. While calculating the index, final result is substracted from 1 to correct the inverse proportion. Simpson index of aquatic insects was determined by using the formula: Simpson's index of dominance: D =∑ ni (ni-1) / N (N-1) Where; ni= Total number of individuals of a particular species N= Total number of individuals of all species Simpson's index of diversity: 1-D (c) Margalef Index (Ma): This index has no limit value and it shows variation depending upon the number of species. Thus it is used for comparision of sites. Margalef index of aquatic insects was determined by using the formula: Ma = (S-1) / ln N Where; S = Total number of species N = Total number of individuals (d) Pielou Evenness Index (J): The ratio of the observed value of Shanon index to the maximum value gives the Pielou Evenness Index result. Its value ranges from 0 to 1. When the value is getting close to 1, it means that the individuals are distributed equally. Pielou Evenness Index was calculated using formula: J=H / H max Where; H = Observed value of Shanon index H max = lnS S = Total number of species (e) McIntosh index (Mc): Its value ranges from 0 to 1. When the value is getting closer to 1, it means that the individuals in a community are homogeneously distributed. McIntosh index of aquatic insects was determined by using the formula: Mc = [ N - √ (∑ ni 2 ) ] / [ N- (N / √ S) ] Where; ni= Number of individuals belonging to i species S= Total number of species N= Total number of individuals

**Data Analysis**

Analysis of water parameters were performed titrimetrically in the laboratory and various diversity indices of aquatic entomofauna were calculated seasonally.

**Results**

1. pH: The maximum seasonal mean value was 7.8 during summer season at Dhobi Ghat (site-1) while the minimum value was 7.0 observed during rainy season at Brindavan Bagh Nalla (site-2).

2. Temperature: Temperature varies from 12.5°C to 40°C. The maximum seasonal mean value was 28.9°C during summer season at Khari Nalla (site-8) while the minimum value was 19.7°C observed during winter season at Kanera Feeder (site-5).

3. Total Dissolved Solid (TDS): The maximum seasonal mean value was 272ppm during summer season at Khari Nalla (site-8) while the minimum value was 223ppm observed during winter season at Brindavan Bagh Nalla (site-2).

4. Transparency: It ranges from 13.5cm to 39cm. The maximum seasonal mean value was 34.2cm during winter season at Dhobi Ghat (site-1) while the minimum value was 17.5cm observed during summer season at the same site.

5. Dissolved Oxygen (DO): The maximum seasonal mean value was 6.9mg/l during winter season at Mahalwar Mandir (site-4) while the minimum value was 3.5mg/l observed during summer season at Dhobi Ghat (site-1).

6. Biochemical Oxygen Demand (BOD): The maximum seasonal mean value was 27.4mg/l during summer season at Fisheries Department (site-7) while the minimum value was 18.4mg/l observed during winter season at Ganga Mandir (site-3).

7. Chemical Oxygen Demand (COD): The maximum seasonal mean value was 33.4mg/l during summer season at Khari Nalla (site-8) while the minimum value was 17.7mg/l observed during winter season at Dhobi Ghat (site-1).

8. Chloride: The maximum seasonal mean value was 123.2mg/l during summer season at Khari Nalla (site-8) while the minimum value was 87.2mg/l observed during rainy season at Mahalwar Mandir (site-4).

9. Total Alkalinity –The maximum seasonal mean value was 165mg/l during rainy season at Bagraj Canal (site6) while the minimum value was 128mg/l observed during summer season at Khari Nalla (site-8).

10. Total Hardness –The maximum seasonal mean value was 226mg/l during winter season near Fisheries Department (site-7) while the minimum value was 185mg/l observed during summer season at Ganga Mandir (site-3).

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11. Nitrate: The maximum seasonal mean value was 6.43mg/l during summer season at Khari Nalla (site-8) while the minimum value was 3.47mg/l observed during winter season at Ganga Mandir (site-3).

12. Phosphate: The maximum seasonal mean value was 0.86mg/l during winter season at Dhobi Ghat (site-1) while the minimum value was 0.69mg/l observed during rainy season at Baghraj Canal (site-6).

**Diversity of aquatic insects in Sagar Lake**

Higher aquatic insect diversity was seen during rainy season with 23 taxa, compared with 13 taxa in winter and 22 taxa in summer season. Figure 4 (bar diagrams 1, 2, 3) shows the pattern of distribution of aquatic insects at different season at different sites in Sagar Lake. The Hemipteran populations peaked during all the seasons. The second most abundant order was Odonata followed by Coleoptera, Diptera and Lepidoptera.

Table

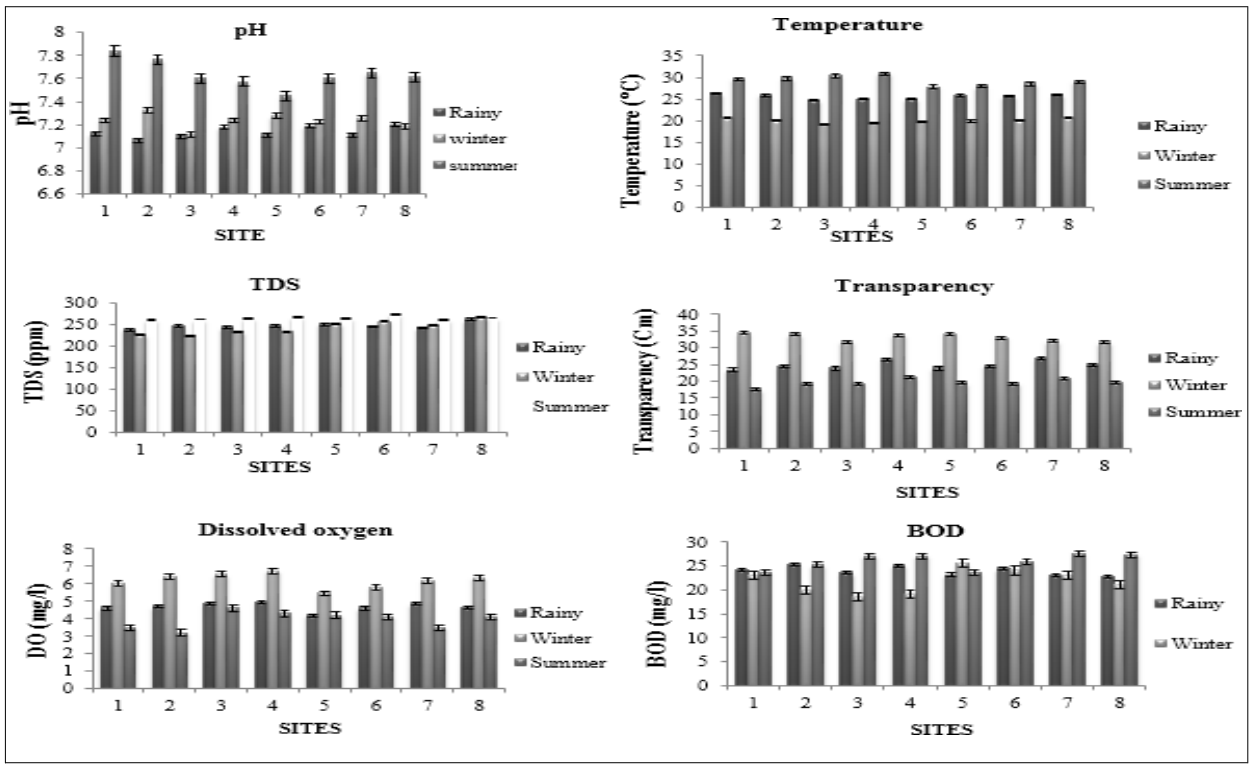


**Fig 2:** Bar diagrams showing seasonal variations in pH, Temperature, TDS, Transarency, Dissolved Oxygen and BOD from different sites of Sagar Lake during 2013 to 2015.

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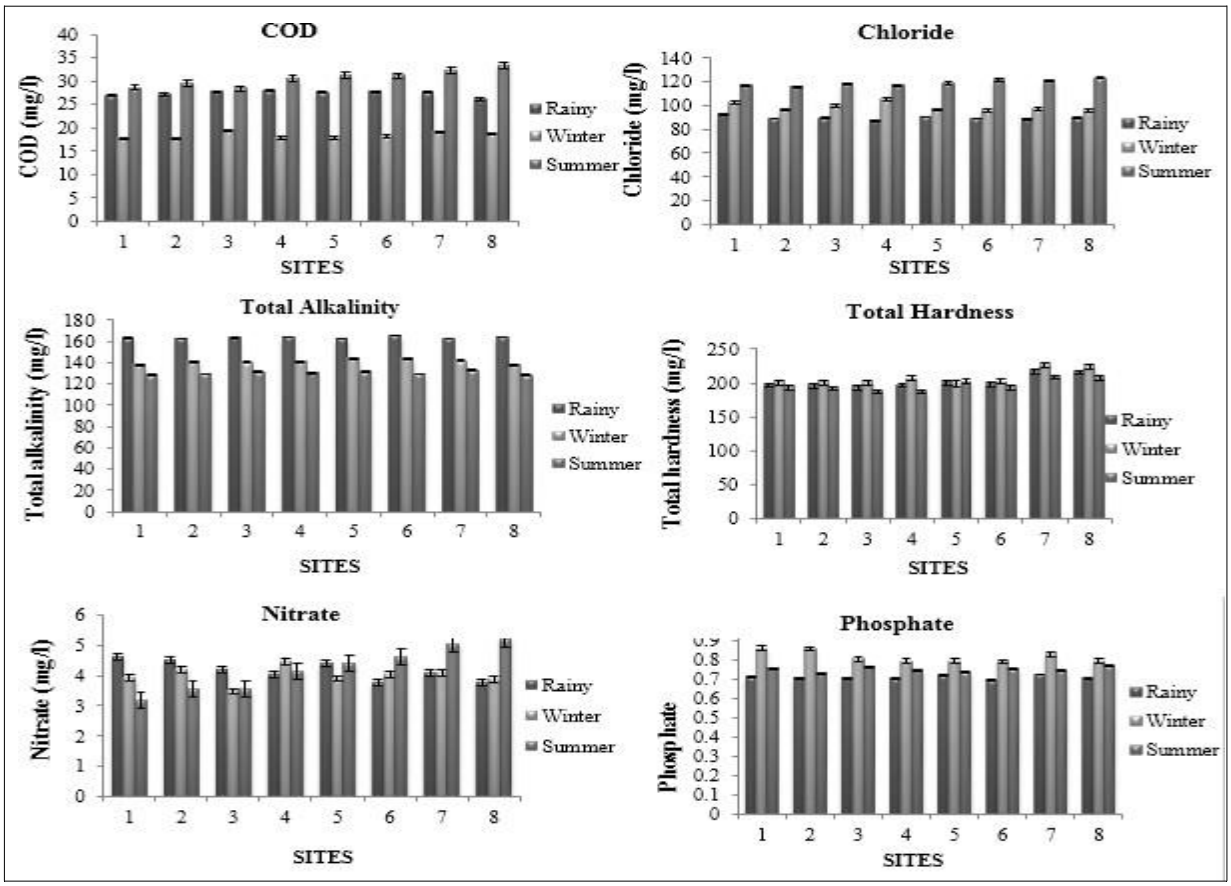


**Fig 3:** Bar diagrams showing seasonal variations in COD, Chloride, TDS, Total Alkalinity, Total Hardness, Nitrate and Phosphate from different sites of Sagar Lake during 2013 to 2015.

## Diversity of aquatic insects in Sagar Lake

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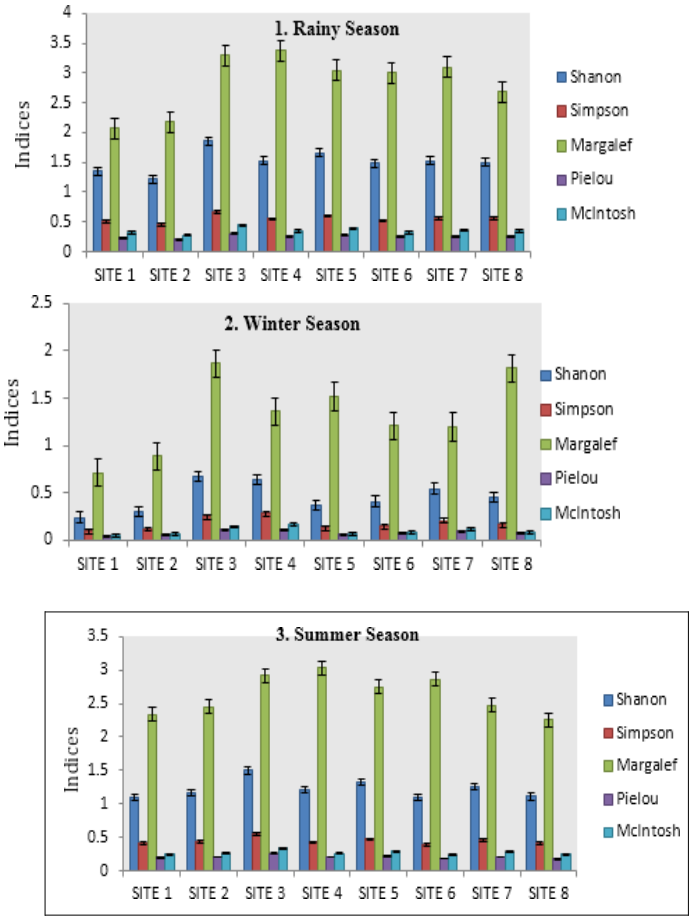


## Discussion

In the present study maximum temperature was during summer season and low during winter season. Similar observation was established by Verma et al. (2012) [20] in the study of Chandola Lake.Transparency was low in summer season and higher during winter season because of settling of sediments, silt and clay after rainy season. Verma et al. (2012) [20] also reported increase in Transparency during their study on Chandola Lake. Minimum amount of TDS was recorded during winter and maximum was recorded during summer season. High TDS was due to contamination from fertilizer, domestic waste water and garbage etc. in the natural surface water body which generally increases during summer season. Similar outcome was reported by Beeton (1965) [4] in some Laurention Great Lakes.

High pH was observed in summer and low in rainy season due to carbonic acid which is brought by rain water. Gonzalves and Joshi (1946) [10] reported that pH is reduced in rainy season due to inflow of rain water which contains

carbonic acid. Dissolved oxygen was higher during winter season similar result was observed by Garg et al. (2009) [9] in Ramsagar reservoir. COD was higher during summer season. Fokmare and Musaddiq (2002) [7] noticed similar seasonal variations in physico-chemical characteristics of Kapsi Lake in Akola district. High value of BOD was observed during summer season. While less BOD was observed in winter because of fall in temperature and decreased biological activity. High value of total alkalinity was recorded during rainy season. Munawar (1970) reported that rain water brings huge quantity of animal contaminant and sewage wastes which results in high value of alkalinity. Similar observation was also made by Agrawal (1990) [2] in Banjara Lake. Hardness was highest during winter season and low value during summer season. Mohanta et al. (2000) [21] reported that higher quantity of hardness is possibly as a result of consistent addition of greater amount of sewage and domestic waste from the adjacent residential areas into the lakes. Chloride value was greater in summer season and minimum in winter season. Nitrate value was high during rainy season and low in winter season. Similarly, high value of nitrate was recorded by Verma et al. (2012) [20] during monsoon season at Chondola Lake. Phosphate value was minimum in rainy season and maximum in winter season. Benjamin et al. (1996) [5] reported that at low temperature constant arrival of residential sewage and cleaning of huge quantity of clothes by laundry worker and dhobis in selected portion of lake are the main cause of increase in phosphate level. Shanon weiner (H) index includes both relative abundance of each species and number of species existing in an area. Shekhar et al. (2008) [23] reported that when Shanon weiner (H) index value is more than 4 it indicates clean water, when value ranges from 3 to 4 it is moderately polluted water and less than 2 specifies heavy pollution of water body. In the present study in Sagar Lake Shannon-Weiner diversity index varied from 0.2403 to 1.8560 at different sites in the different seasons which indicated polluted state of Sagar Lake. The values of Simpson dominance index of aquatic insects of Sagar Lake were minimum low in winter season while maximum during rainy season. Similar observations were made by Ganai (2011) [24] in reporting high value of dominance index of aquatic insects during rainy season while minimum during winter season in all the ponds selected for aquatic insects diversity at Aligarh. Margalef index showed lower values which was according to the variations of richness of the aquatic insect species of Sagar Lake. Similar observation was made by Hazarika (2013) [11] where low values of Margalef index in Satajan wetland were reported. The values of Pielou and McIntosh indices in the present investigation indicates that the distribution of aquatic insects were uneven at all the sites of Sagar Lake in different seasons.

## Conclusion

Different physico-chemical parameters of Sagar Lake had displayed seasonal variations due to different kinds of waste entering into the lake from different source and diversity indices of aquatic entomofauna also fluctuates at different sites, this may indicates some sort of disturbances related to availability of food, niche separation, tolerance and adaption

for aquatic insects. Thus it may be concluded that water body under investigation was under stress and perturbed.

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