Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Special Issue [1]2022 : 1353-1358

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
ORIGINAL ARTICLE **OPEN ACCESS**

Diversity and Seasonal Variation of Aquatic Insect Communities in Varuna Lake, Mysore, Karnataka, India.

H. R. Abhilash[1*] and M. Mahadevaswamy[2]
[1] Research scholar, Department of Zoology, Yuvaraja's College (Autonomous), University of Mysore, Mysore -570005, Karnataka, India.
[2]Professor of Zoology, Department of Zoology, Yuvaraja's College (Autonomous), University of Mysore, Mysore - 570005, Karnataka, India.
***Corresponding author:**: abhilash2787@gmail.com

ABSTRACT
A study was carried out to investigate the composition and seasonal fluctuation of aquatic insects in Varuna Lake, Mysore, India. Across different seasons, a total of 16 aquatic insect genera representing 5 orders were discovered.With 6 species and 5 families, the order Hemiptera was identified to be the most dominant, followed by Coleoptera with 5 species and 2 families. Based on the computation of dominance status as per Engelmann's scale in different seasons, two species of Ephemeroptera, Cloeon sp. and Baetis sp., were found to be numerically most dominant in all the seasons. The Shannon index and species evenness value were within the range of 1.824 - 2.661 and 0.6882 - 0.8943, respectively, suggesting a diversified and relatively evenly distributed aquatic system.A biomonitoring approach was used to determine the quality of the water by employing family level biotic indices, which revealed moderate to good water quality conditions. The present study sheds light on the aquatic insect community of Varuna Lake and suggests the possibility of using them for biomonitoring programmes.
Key words: *Aquatic insects, biomonitoring, relative abundance, diversity, Hemiptera, Varuna Lake*

Received 14.02.2022 Revised 19.03.2022 Accepted 24.04.2022

INTRODUCTION

Among freshwater organisms aquatic insects are most numerous and widespread. There are some 45,000 species described worldwide which may account to about 3 percent of all insect species[1].In India, it is estimated that over 5000 species of aquatic insects inhabit diverse inland freshwater habitats[2].Aquatic insects are an essential part of the aquatic food web, contributing significantly to maintaining the stability and functioning of the ecosystem, especially in nutrient recycling. They take on various ecological roles as herbivores, detritus feeders and predators[3, 4].Owing to their high abundance, resulting from their prolific power of reproduction and short generation time, high turnover rate, and fast colonization of various environments, they make up the dominant fauna of lentic water bodies [5]. As a result they are widely used as model organisms in several Biomonitoring assessments in analyzing human impact on freshwater ecosystems[6-9].

In India, recently, the use of aquatic insects as biomonitoring tools along with physicochemical characteristics to determine water quality is gaining prominence. Several researchers have undertaken biomonitoring approaches and have agreed that the community structure of aquatic insects specifically reflects the prevailing environmental conditions of aquatic habitats[10-14].The present research aims to examine the composition of the aquatic insect fauna in Varuna Lake and to assess water quality based on aquatic insect assemblages in different seasons.

MATERIAL AND METHODS

Study area

Varuna Lake is situated on the outskirts of Mysore district in the Indian state of Karnataka (76°74'58.72" E latitude, 12°27'50.31" N longitude, and 719 meters above the mean sea level). The lake is situated close to the Mysore-Trichy road and is surrounded by the three villages *viz*., Varuna, Chikkalli and Varakodu (**Figure 1**). The lake never runs out of water since it is connected to the Varuna canal, which feeds the Cauvery river water during the summer months. The lake's water is also replenished by rainfall and surface runoff from the catchment area. The lake has attracted many nature and adventure enthusiasts because of the water sports activities provided by Outback Adventures in the lake vicinity.The lake contains diverse aquatic vegetation, as evidenced by many aquatic plants such as *Vallisneria spiralis*, *Nelumbonucifera*, *Hydrilla*sp., *Nymphae*sp., *Nitella* sp., *Typha* sp. etc. The lake water is constantly set in motion by winds, which aids in the dissolution of oxygen from the air.Thus, dissolved oxygen concentrations stay high throughout the year, providing optimum conditions for fish culture.

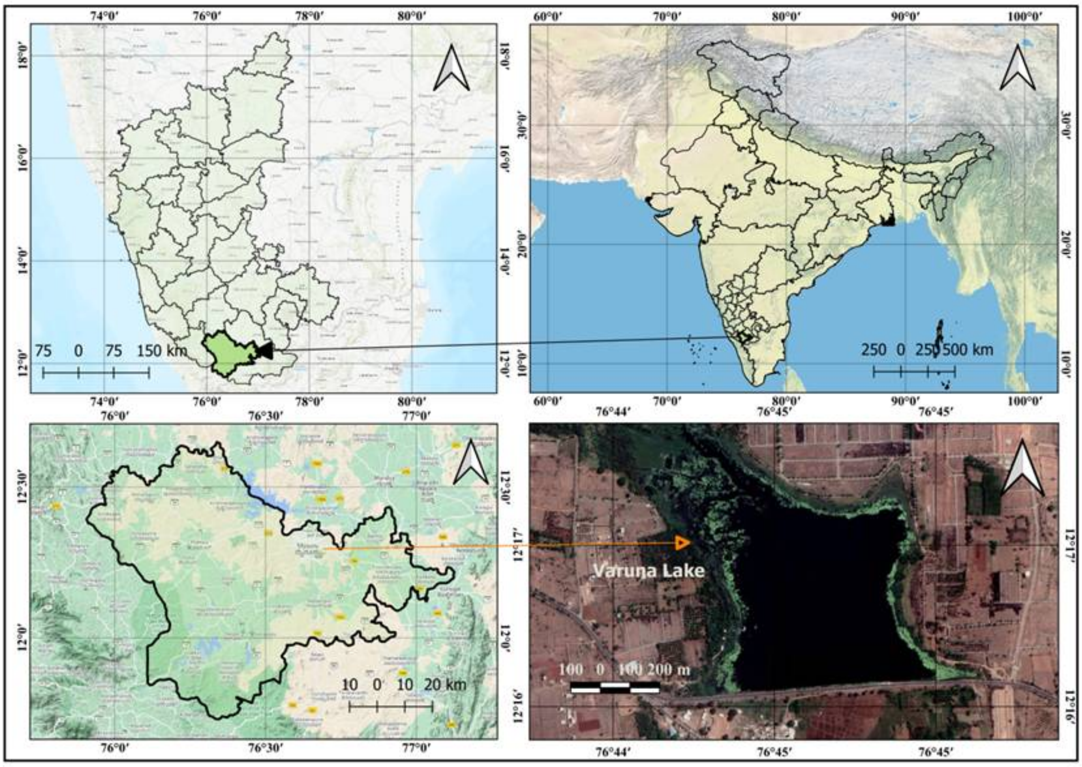

Figure 1: Geographical map showing the location of Varuna Lake within Mysore District, Karnataka India.

MATERIAL AND METHODS

The collection of aquatic insects was done using a circular pond net, from three sites between 7.00 am to 10.00 am, each month from October 2017 to September 2018. The pond net was hauled over the vegetation for a fixed time and the sample was transferred to a white tray, where the insects were sorted and transferred to a polythene jar and preserved in 4% formalin. Three such hauls constituted a sample for each site[15-17].The fixed specimens were identified using a stereo zoom microscope based on the external morphology following standard keys[18-20].Data analysis was done using PAST software. Community structure analysis such as abundance, evenness, species diversity (Shannon-Weiner's index), dominance index (Berger-Parker index) and Margalef index was done for the pooled insects' samples for each month. To evaluate the biological water quality, the biological monitoring working party (BMWP) score was determined by adding the family level biotic scores based on thepollution tolerance of aquatic insects. The average score per taxon was obtained by dividing the BMWP score with the number of taxa present[21].

RESULTS AND DISCUSSION

In the currentstudy 16 species of aquatic insects distributed among 11 families, representing 5 orders, *viz.*Hemiptera, Coleoptera, Ephemeroptera, Odonata and Trichoptera were recorded. Among these the order Hemiptera was numerically most abundant representing 36% of the total fauna as shown in the **Figure 2**. The Hemiptera had 6 species from 5 families *viz*. *Ranatrafiliformis* and *Laccotrephes* sp. (Nepidae), *Anisops* sp. (Notonectidae), *Paraplealiturata* (Pleidae),*Diplonychusrusticus* (Belastomatidae) and *Mesovelia*sp.(Mesovellidae).The Hemiptera's dominance comes mostly from its capacity to absorb atmospheric oxygen using different respiratory organs (plastron, syphon, etc.), enabling them to minimize their dependence on dissolved oxygen in water**[23]**. Several workers have reported the dominance of Hemiptera in lentic water bodies**[24, 25]**. Coleoptera was the second dominant orderin terms of number of species and accounted for 20% of the total fauna, with 5 species belonging to 2 familiesviz., *Laccophilus anticatus*, *Laccophilus inefficiens and Berosussp.*(Dytiscidae) and *Gyrinus*sp. and *Dineutusspinosus* (Gyrinidae). Order Ephemeroptera was represented by 2 species *Baetis*sp. and *Cloeon*sp.(Baetidae) and accounted for 29% of the fauna. Odonata was also represented by 2 species belonging to 2 families*viz*. *Lestes*sp. (Lestidae) and *Ischnura*sp. (Coenagrionidae) and accounted for 10% of the fauna. The order Trichoptera was represented by a species and accounted for 5% of the total population.

The relative abundance of aquatic insects and their dominance status were determined from Engelmann's scale [22] and is depicted in Table 1. All the species observed during the survey were represented inthe post monsoon season.A high abundance of aquatic insects in post-monsoons is attributed to high dissolved oxygen content, low temperature, and low turbidity [26].It was found that *Cloeon* sp. was dominant during post monsoon season and the remaining 13 species were subdominant and two were in the recedent status.Several workers have reported an increase in the abundance of aquatic insect fauna during the post-monsoon season[27, 28].During the pre-monsoon period, the number of insects recorded was reduced to 13, out of which *Paraplealituarata* and *Baetis* sp. were in dominant status while the remaining were in subdominant status. Monsoon season was least represented with only 9 species belonging to 7 families.A lower occurrence of aquatic insects during the monsoon season could be related to increased sedimentation resulting from heavy rainfall, leading to increased turbidity, decreased dissolved oxygen concentration, and low primary productivity [29]. *Cloeon* sp. of Ephemeroptera was represented in greater numbers and was Eudominant, and *Baetis* sp. (Ephemeroptera) and *Ischnura* **sp.** (Odonata) were in the dominant category. The members of the order Ephemeroptera have traditionally been known to be the markers of good water quality[6].

Table 1: Relative abundance of aquatic insect species recorded in different seasons in Varuna Lake

Postmonsoon season			**Pre-monsoon season**		
Taxa	RA (%)	Status	Taxa	RA (%)	Status
Ranatrafiliformis	5.37	Subdominant	*Ranatrafiliformis*	9.59	Subdominant
*Laccotrephes*sp.	2.39	Recedent	*Laccotrephes*sp.	2.74	Recedent
*Anisop*sp.	8.36	Subdominant	*Anisop*sp.	2.74	Recedent
Paraplealiturata	8.06	Subdominant	*Paraplealiturata*	20.09	Dominant
Diplonychusrusticus	8.36	Subdominant	*Diplonychusrusticus*	7.76	Subdominant
*Mesovelia*sp.	5.37	Subdominant	*Mesovelia*sp.	4.11	Subdominant
Laccophilusanticatus	6.27	Subdominant	*Berosus*sp.	8.68	Subdominant
Laccophilusinefficiens	1.79	Recedent	*Gyrinus*sp.	6.85	Subdominant
*Berosus*sp.	5.37	Subdominant	*Dineutusspinosus*	2.74	Recedent
*Gyrinus*sp.	8.06	Subdominant	*Baetis*sp	15.98	Dominant
Dineutusspinosus	3.58	Subdominant	*Cloeon*sp.	5.48	Subdominant
*Baetis*sp	8.96	Subdominant	*Ischura*sp.	9.59	Subdominant
*Cloeon*sp.	14.33	Dominant	*Caddisfly larva*	3.65	Subdominant
*Lestes*sp.	3.58	Subdominant			
*Ischura*sp.	5.97	Subdominant	**Monsoon Season**		
Caddisfly larva	4.18	Subdominant	Taxa	RA (%)	Status
			Ranatrafiliformis	2.22	Recedent
			*Anisop*sp.	2.22	Recedent
			Diplonychusrusticus	7.41	Subdominant
			Laccophilusinefficiens	2.96	Recedent
			*Berosus*sp.	6.67	Subdominant
			*Baetis*sp	22.22	Dominant
			*Cloeon*sp.	34.07	Eudominant
			*Ischnura*sp.	14.81	Dominant
			Caddisfly larva	7.41	Subdominant

Note: Relative abundance: < 1= Subrecedent; 1.1 -3.1 = Recedent; 3.2-10 = Subdominant; 10.1-31.6 = Dominant and>31.7%= Eudominant**[22].**

Table 2: Seasonal fluctuations in the Diversity indices and Biomonitoring Scores in Varuna Lake

Indices	Post-monsoon	Pre-monsoon	Monsoon
Shannon- Weiner index	2.661	2.366	1.824
Evenness index	0.8943	0.8197	0.6882
Margalef index	2.58	2.227	1.631
Berger-Parker index	0.1433	0.2009	0.3407
BMWP score	63	55	40
ASPT	5.7	5.5	5.7

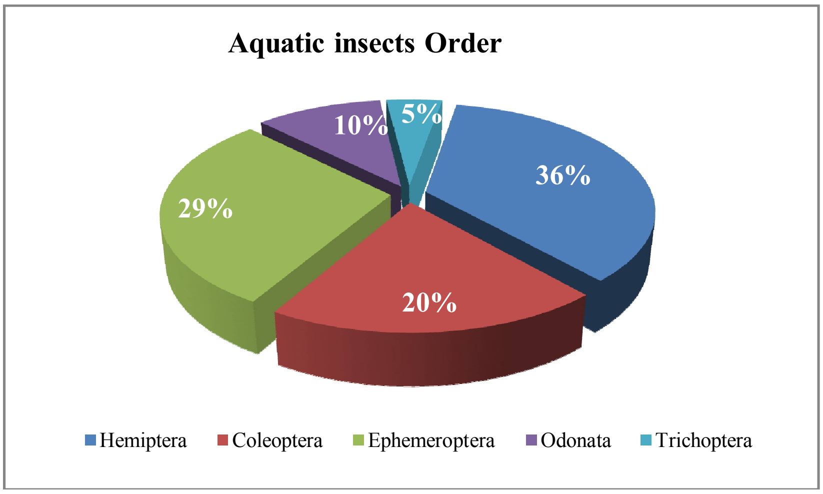

Figure 2: Relative abundance of aquatic insect orders

Table 2shows seasonal variations in the diversity index scores derived for this study using aquatic insect assemblages. Environmental stress can also be measured with the diversity index [30]. The Shannon-Weiner diversity index (H') during the study ranged from 1.824 to 2.661.The Shannon index value was high during the post-monsoon season (2.661), indicating a greater diversity of aquatic insects. A higher Shannon index value suggests healthier ecosystems [31].The maximum Evenness value of 0.8943was also recordedin post-monsoon which suggests balanced distribution of insects in the ecosystem and a minimum value 0.6882in monsoon which indicated a semi balanced habitat which is supported by a high Berger-Parker index of 0.3407 wherein the order Ephemeroptera had high abundance[30]. Margalef's score of greater than three suggests clean conditions, while values lower than that point to severe pollution, and intermediate values suggest moderate contamination[32]. Margalef water quality index in the present study ranged between 1.631- 2.58 indicating moderate pollution [33].

The biological water quality index BMWP score revealed overall good water quality condition during postmonsoon and pre-monsoon season and moderate water quality in monsoon season as shown in Table 2. The BMWP index was obtained by summing the scores of the families present, with each family's score representing their pollution tolerance.A higher BMWP score implies the presence of pollution-sensitive families, whereas a low value suggests the presence of pollution-tolerant families[34].ABMWP score of 100 or higher indicates excellent water quality, whereas a score of less than 10 indicates poor water quality[21].The BMWP score in this study ranged from 40 to 63, suggesting moderate to good water quality.The average score per taxon is determined by dividing the BMWP by the total number of families present in the sample. The ASPT score represents the mean tolerance score of all taxa within the community[21, 34]. The ASPT in the study was in the range of 5.5–5.7, indicating good water quality. The diversity of aquatic insect communities in a given water body reflects the environmental conditions, with sensitive species being eliminated with increasing pollution and tolerant species becoming more abundant [6].The prevalence of pollution sensitive taxa such as Ephemeroptera and Trichoptera in the current study implies that the lake's water quality is relatively undisturbed. This study highlights the importance of urban lakes in supporting the biodiversity of insects and their usage in biomonitoring programmes, which can be incorporated into long-term water quality studies to evaluate the health of the water bodies.

CONCLUSION
The current study establishes a baseline on the diversity and community structure of aquatic insects in Varuna Lake. A total of 16 species of aquatic insects distributed among 11 families, representing 5 orders (Hemiptera, Coleoptera, Ephemeroptera, Odonata, and Trichoptera) were recorded. The abundance and community structure of aquatic insects showed seasonal changes. A high number of aquatic insect taxa and a high Shannon diversity index were recorded during the post-monsoon season, which was due to relatively good water quality conditions, which is evidenced by a high BMWP score and an ASPT score. The presence of pollution-sensitive orders such as Trichoptera and Ephemeroptera during the entire study period suggests a clean water condition. This is consistent with the diversity indices and biotic indices (BMWP and ASPT) measured in all three seasons, which show that the Varuna Lake has moderate to good water quality. The study demonstrates the importance of aquatic insects in assessing the health of water bodies and how they can be used in long-term biomonitoring and conservation programmes.

ACKNOWLEDGMENT
Authors are grateful to the Principal of Yuvaraja's College, Mysore for providing the necessary laboratory facilities. Furthermore, the researchers sincerely thank Mr. Goutham. S and Mr. Lokesh. D for their assistance during the field study.

REFERENCES
1. Balaram,P. (2005). "Insect of tropical streams," *Curr. Sci.*.89: 914.
2. Subramanian, K.A and Sivaramakrishnan, K.G. (2007). "Aquatic Insects of India-A fieldguide," *Ashoka Trust Ecol. Environ. Bangalore India*. 1–62
3. Daly,H.V., Daly, P. E. H. V., Doyen,J. T., Purcell, A. H and Purcell,A. P. of E. A. H. (1998). *Introduction to Insect Biology and Diversity*. Oxford University Press.
4. Dijkstra, K.-D. B.,Monaghan, M. Tand Pauls, S. U. (2014). "Freshwater Biodiversity and Aquatic Insect Diversification" *Annu. Rev. Entomol.*: 59(1): 143–163.doi: 10.1146/annurev-ento-011613-161958.
5. RoY, S. P.,Pathak, H. S and Kumar, V. (1988)."Faunistic composition of aquatic insects of eastern Bihar with notes on some aspects of their ecology,": 49–57.
6. Rosenberg D. M. and Resh, V. H.Eds.,(1993). *Freshwater Biomonitoring and Benthic Macroinvertebrates*. Springer US.
7. Bae,Y. J., Kil, H. K and Bae, K. S. (2005). "Benthic macroinvertebrates for uses in stream biomonitoring and restoration," *KSCE J. Civ. Eng*:9(1):55–63.doi: 10.1007/BF02829098.
8. Balachandran, C.,Dinakaran, S.,Alkananda, B.,Boominathan, M and Ramachandra, T. V.(2012). "Monitoring Aquatic Macroinvertebrates as Indicators for Assessing the Health of Lakes in Bangalore, Karnataka," *Int. J. Adv. Life Sci.* : 5(1): 19–33.
9. Bonada, N.,Prat, N.,Resh, V.H.and Statzner, B. (2006). "Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches," *Annu. Rev. Entomol.*, 51:495–523.doi: 10.1146/annurev .ento. 51.110104.151124.
10. Barman, B.,Priti, G.,Choudhury, D., Arpita, D.,and Gupta, S. "Biomonitoring in Lentic Ecosystems of Irongmara, District Cachar, Assam, India, with Special reference to Aquatic Insect community," *Int. Res. J. Environ. Sci.*2014: 3(8):26–35.
11. PrommiT. and Payakka, A. (2015). "Aquatic Insect Biodiversity and Water Quality Parameters of Streams in Northern Thailand," *Sains Malays.*, :44(5):707–717.doi: 10.17576/jsm-2015-4405-10.
12. Barman B.and Gupta, S.(2015) "Aquatic insects as bio-indicator of water quality- A study on Bakuamari stream, Chakras hila Wildlife Sanctuary, Assam, North East India," *J. Entomol. Zool. Stud.*:3(3):178–186.
13. [13] Jose,R. and Cherian, S. (2019)."Biomonitoring of a selected pond ecosystem using Aquatic insects," *Sci. Chron.*: 8(2):9–13.
14. Chakravarty,T. and Gupta, S. (2021)."Monitoring of river health using aquatic insects: A study on Jatinga River, North East India," *Aquat. Res.*:4(4).doi: 10.3153/AR21031.
15. Macan T. T ,and Maudsley R,(1968). "The insects of the stony substratum of Windermere," *Trans. Soc. Br. Entomol* :18:1–18.
16. Brittain, J. E. (1974)."Studies on the lentic Ephemeroptera and Plecoptera of Southern Norway," 21:135–151.
17. Subramanian, K. A., and Sivaramakrishnan, K.G. (2007). "Aquatic Insects for Biomonitoring Freshwater Ecosystems- A Methodology Manual," *Asoka Trust Res. Ecol. Environ.*,31.
18. [18] Khan,R. A. and Ghosh, L. K.(2001). *F*aunal diversity of aquatic insects in freshwater wetlands of South Eastern West Bengal. Kolkata: Zoological Survey of India. 200-208
19. Merritt, R. W., Cummins, K. W.and Berg, M. B.Eds., (2008). Introduction to Aquatic Insects in North America, 4th edition. Dubuque, Iowa: Kendall Hunt Publishing Company.
20. Thirumalai G,(2013). "Insecta: Hemiptera (Aquatic and Semi -aquatic)," in Fauna of Karnataka, India, Zoological Survey of India, 133–162.
21. Mandaville, S. M. (2002). Benthic Macroinvertebrates in FreshwatersTaxa Tolerance Values, Metrics, and Protocols. Canada: Soil & Water Conservation Society of Metro Halifax,

22. Engelmann, H. D. (1973).“Investigations into the detection of predozoogenic components in the defined ecosystem.” Researches StaatlMus Naturk de Gorlitz..
23. Thorpe, W. H. (1950). “Plastron Respiration in Aquatic Insects,” *Biol. Rev.*, 25(3): 344–390.doi: https:// doi.org/10.1111 /j.1469-185X.1950.tb01590.x.
24. Barman,A. and Baruah, B. K. (2013). “Aquatic insects of KaplaBeel, a flood plain wetland of Barpeta District of Assam, India,” *Clar.-Int. Multidiscip. J.*, 20-23
25. [25] Abhijna, U. G.,Ratheesh, R and Kumar, A. B. (2013). “Distribution and diversity of aquatic insects of Vellayani lake in Kerala,” *J. Environ. Biol.*, 34(3):605–611.
26. [26] Sharma, A.,Sharma, R.and Anthwal, A. (2008). “Surveying of aquatic insect diversity of Chandrabhaga river, Garhwal Himalayas,” *The Environmentalist*, :28:395–404.doi: 10.1007/s10669-007-9155-z.
27. [27] Takhelmayum,K. and Gupta, S.(2011). “Distribution of aquatic insects in phumdis (floating island) of Loktak Lake, Manipur, northeastern India,” *J. Threat. Taxa*. 3(6):1856–1861.doi: 10.11609/JoTT.o2526.1856-61.
28. [28] Barman,A. and Baruah, B. K. (2018). “Influence of physico-chemical characteristics of water in seasonal abundance of insects of KaplaBeel, Assam, India,” *Int. Res. J. Biol. Sci.*, 7(3):1–8.
29. [29] Payakka,A. and Prommi, T.-O. (2014). “Aquatic Insects Biodiversity and Water Quality Parameters of Receiving Water body,” *Curr. World Environ. J.* 9(1): 53–58.doi: 10.12944/CWE.9.1.08.
30. [30] Türkmen,G.andKazanci, N. (2010). “Applications of various biodiversity indices to benthic macroinvertebrate assemblages in streams of a national park in Turkey,” : 16.
31. [31] Metcalfe, J. L. (1989). “Biological water quality assessment of running waters based on macroinvertebrate communities: History and present status in Europe,” *Environ. Pollut.*: 60(1): 101–139.doi: 10.1016/0269-7491(89)90223-6.
32. Lenat, D.,Smock, L. and Penrose, D. (1980). “Use of benthic macroinvertebrates as indicators of environmental quality,” in *Biological Monitoring for Environmental Effects*, Toronto, Canada.: Lexinton Books, 97–112.
33. Dinakaran,S. and Anbalagan, S. (2007).Anthropogenic impacts on aquatic insects in six streams of south Western Ghats,” *J. Insect Sci.* 7(1): 37.doi: 10.1673/031.007.3701.
34. Sivaramakrishnan, K. G. (1992). Composition and Zonation of Aquatic Insect Fauna of Kaveri and its Tributaries and the Identification of Insect Fauna as Indicator of Pollution.pp99

CITATION OF THIS ARTICLE

H. R. Abhilash and M. Mahadevaswamy. Diversity and Seasonal Variation of Aquatic Insect Communities in Varuna Lake, Mysore, Karnataka, India. Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022 : 1353-1358