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Journal of Microbiology & Experimentation

Editorial

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Microbiomes of freshwater lake ecosystems

Volume 6 Issue 6 - 2018

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Received: November 25, 2018 | **Published:** December 05, 2018

Editorial

Water ecosystems in form lakes in diverse regions provide indispensable water resources for humans. The microbiomes in lake ecosystems are a suitable bioresources for agriculture, industry and allied sector. The microbiomes from lake ecosystems may be isolated using different nutrient combination and specific media for different groups of bacteria. There are many reports on microbial community of lake ecosystem and it was found microbes has been identified from different phylum including Actinobacteria, Cyanobacteria, Acidobacteria, Caldeserica, Calditrichaeota, Verrucomicrobia, Chlorobi, Planctomycetes, Nitrospirae, Chloroflexi, Bacteriodetes, Firmicutes and Proteobacteria. Microbes are ubiquitous in nature, inhabiting almost every habitat including soil, water, air and associated with plants. The microbes are present in extreme environmental conditions like hot springs,[1–4] saline environments,[5,6] cold environments,[7–10] acidic/alkaline soil,[11,12] drought[13–15] and plant associated.[16–20] Microbes play central roles in regulating elemental cycles like carbon, nitrogen, and sulfur. Lake is an area which is filled with water and surrounded by land. It is localized in a basin, apart from any river or other outlet that serves to feed or drain the lake. Microbiome varies among lakes with different environmental variables.

The microbiome in the freshwater lake ecosystems have been investigated worldwide e.g. Toolik Lake, Alaska, USA,[21] Adirondack lake, New York,[22] Lake Loosdrecht, The Netherlands,[23] Crystal Bog Lake and Sparkling Lake, USA,[24] Lake Cadagno, Switzerland,[25] Lake Fuchskuhle, Germany,[26] Crater Lake, USA,[27] Lake Soyang, South Korea,[28] Lake Biwa, Japan,[29] Lake Washington,[30] Lake Kasumigaura, Japan,[31] Lake Tanganyika, Africa,[32] Lake Taihu, China,[33] Lake Puma Yumco,[34] Roopkund Lake, India,[35] Vembanad Lake, India,[36] Dianchi Lake, China,[37] Lake Erie, USA,[38] Laurentian Great Lakes,[39] Chandra Tal Lake, India,[9] Dashair Lake, India,[9] Lake Baikal, Russia,[40] Claytor Lake, USA,[41] and Lake Baikal, Russia.[42]

The microbes are ubiquitous in nature and also have been reported as niches or host-specific from all habitat study e.g. from cold habitats,[7,43–45] from thermal springs,[1-3] from saline habitats,[5,46] from drought,[47–49] from soil[12,15,18] and as plant microbiomes.[13,16,19,20,50–53] The niche-specific microbes from freshwater lakes have been reported e.g. *Zoogloea* from Toolik Lake, Alaska, USA; *Legionella* and *Prevotella* from Adirondack lake, New York; *Planktothrix* from Lake Loosdrecht, The Netherlands; *Amoebobacter, Desulfocapsa,* and *Lamprocystis* from Lake Cadagno, Switzerland; *Haliscomenobacter* and *Spirosoma* from Lake Gossenkollesee, Austria; *Bdellovibrio, Eikenella, Polaromonas,* and *Rathayibacter* from Crater Lake, USA; *Caenibacterium, Hymenobacter, Methylocystis, Novosphingobium, Paucimonas* and *Propionivibrio* from Lake Kasumigaura, Japan; *Aminnobacter, Gelidibacter, Kaistella, Mesorhizobium, Methylocapsa, Niastella, Rhizobium* and *Tetrasphaera* from Lake Taihu, China; *Plantibacter* from Chandra Tal Lake, India; *Massilia* and *Nitrosomonas* from Dianchi Lake, China; *Brevibacillus, Hafinia,* and *Klebsiella* from Manasbal Lake, India; *Sanguibacter* from Roopkund Lake, India on review of 27 freshwater lake ecosystems present in worldwide.

A huge number of novel bacteria belonging to various classes and families have been reported from freshwater lake ecosystem worldwide e.g. *Ferribacterium limneticum,* CdA-1 Coeur d'Alene Lake,[54] *Hymenobacter aquatilis,* HMF3095^T Artificial lake,[55] *Sphingobium fontiphilum,* Chen16-4^T Chengcing Lake,[56] *Limnobacter thiooxidans*, CS-K1 Chiemsee Lake,[57] *Desulfovibrio idahonensis,* CY1^T Coeur d'Alene,[58] *Thiobaca trueperi,* Eutrophic lake,[59] *Listeria marthii*, FSL S4-120^T Finger Lakes[60] *Sphingomonas hengshuiensis*, WHSC-8^T Hengshui Lake,[61] *Kinneretia asaccharophila*, KIN192^T Kinneret Lake,[62] *Algoriphagus aquatilis* A8-7^T Longhu Lake,[63] *Limnohabitans curvus*, MWH-C5^T Mondsee Lake,[64] *Cloacibacterium rupense*, R2A-16^T Rupa Lake,[65] *Undibacterium seohonense,* SHS5-24^T Seoho lake,[66] *Polynucleobacter difficilis,* AM-8B5^T Sevan Lake,[67] Flavobacterium *chuncheonense* Soyang Lake,[68] *Flavobacterium soyangense,* IMCC26223^T Soyang Lake,[69] Flavobacterium *luteum* IMCC26026^T, Soyang Lake,[68] *Mucilaginibacter soyangensis*, HME6664^T Soyang Lake,[70] *Flavobacterium lacicola,* IMCC25901^T Soyang lake,[71] *Flavobacterium saliperosum,* S13^T, Taihu Lake,[72] *Roseomonas lacus* TH-G33^T Taihu Lake,[73] *Rhodoluna lacicola*, MWH-Ta8^T Taihu Lake,[74] *Nocardioides taihuensis*, X17^T Taihu Lake,[75] *Lysobacter oligotrophicus,* 107-E2^T Tanago Ike,[76] and *Nocardioides ungokensis*, UKS-03^T Ungok Lake.[77]

Conclusion

Microbial community play a central role in global environmental processes and earth biogeochemistry, with bacteria being the most important component of microbial community responsible, in aquatic ecosystems, for the organic matter mineralization and nutrient recycling processes. Microbiome represents the richest gamut of molecular and chemical diversity in nature, as they comprise the simplest yet dynamic forms of life. Future studies might focus on analysing the more bacterial community from diverse lakes ecosystem in different environmental conditions of salinity, pH, temperatures, osmotic potential and pressure in order to decipher the potential role in nutrients cycling of the microbial community present which is largely unexplored reservoir of resources for innovative applications useful to mankind.

Acknowledgments

The authors are grateful to Prof. Harcharan Singh Dhaliwal, Vice Chancellor, Eternal University, Baru Sahib, Himachal Pradesh, India for providing infra-structural facilities and constant encouragement.

Conflicts of interest

All authors declare that they have no conflicts of interest to this work.

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