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ACKNOWLEDGEMENTS. We thank the owners of the fishponds for providing relevant information and allowing sample collection from the ponds. We also thank FIST-DST, for providing the infrastructural facilities. We thank Ms Bipasha Dev Gupta, Ms Rajashree Saikia, Ms Nami Prasad and Ms Poppy Rajbongshi for their help during the study.

Received 22 August 2016; revised accepted 20 March 2018

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Largest freshwater lake 'Loktak' in Manipur needs urgent conservation

Wetlands are one of the most productive ecosystems that support diverse and unique habitats[1]. Loktak Lake in Manipur, India is the largest freshwater lake (area of 287 km^2) which has been included under the Ramsar Convention and also listed under the Montreux record. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands[2]. The most unique feature of the Loktak Lake is the presence of floating 'phoomdis', which are the massive heterogenous masses of soil, vegetation and organic matter in different stages of decay and present in various sizes. People of Manipur are dependent on Loktak Lake and phoomdis for different economic activities like fishing, agriculture, fish farming, trading of lake products, traditional handicraft made of lake products such as mats, baskets and other woven goods, etc.[3]. In Manipur agriculture is not limited to land; people use the phoomdis for agriculture and even build houses on them[4]. It is a rich ecosystem harbouring 81 species of birds; 25 species of reptiles; 6 species of amphibians and 22 species of mammals, migratory fish from Chindwin–Irrawaddy basin of Myanmar, migratory waterfowl and an endangered species of Eld's deer, i.e. the sangai[5]. The only floating National Park in the world is Keibul Lamjao (40 km^2), is situated on the largest phoomdi of Loktak Lake. Important vegetation of the phoomdis includes *Zizania latifolia*, *Eichornia crassipes*, *Lersia hexandra*, *Cynodon* spp., *Phragmites karka*, *Oryza sativa*, *Limnophila* spp., *Sagitlaria* spp., *Saccharum latifolium*, *Erianthus pucerus*, *Erianthus ravennae*, *Carex* spp., etc. The most dominant species is *P. karka* which has nutritional, medicinal and cultural significance[2] and is also used as fodder and fuel, in handicrafts and even as house-building material[5]. Metagenomic approaches revealed a unique microbial diversity of phoomdis[6]. They are reported to harbour microorganisms with economic potential having diverse enzymatic activities[7]. Various bacteria and actinomycetes, producing antimicrobial compounds of medical importance, have been isolated from Loktak Lake[8,9].

The present study was undertaken to isolate bacteria producing multiple enzymes as well as those having plant growth promoting potential from Loktak Lake. The bacterial isolates obtained from the phoomdi sediment and lake water were screened for enzyme production (amylase, lipase, protease, cellulase, chitinase, xylanase, pectinase) and plant growth promoting factors (siderophore production, indoleacetic acid (IAA) production, nitrogen fixation, hydrogen cyanide (HCN) production, phosphate solubilization, ammonia production) and also for antifungal activity. The presence of plant growth promoting microorganisms was expected from phoomdi sediment, due to the fact that the local people use phoomdi sediment as a biofertilizer in agriculture. It exhibits good plant growth promotion which may be attributed to the presence of bacteria with plant growth promoting potential. Microorganisms present in the phoomdis contribute in nutrient recycling by secreting various hydrolytic enzymes and make the nutrients available to plants in absorbable form. Screening revealed the presence of multienzyme-producing bacterial isolates as well as isolates producing various plant growth promoting factors and having antifungal and antimicrobial activities against pathogens. These isolates from Loktak Lake have the potential to be used for the production of industrially important enzymes and in agriculture as plant growth promoters. Among the 26 Loktak bacterial isolates, *Enterobacter tabaci* strain KSA9 (accession no. MH005094) is found to produce siderophore, IAA, involved in nitrogen fixation, HCN production, phosphate solubilization and ammonia production. *Enterobacter tabaci* strain KSA9 can be used for sustainable agriculture in wetlands. *Aeromonas hydrophila* strain VSA7 (accession no. MG966450) produces amylase, lipase, protease, cellulase and chitinase (data not shown) which finds application in industries. Therefore, microbes from Loktak Lake have the potential to be used in agricultural and industrial applications.

However, due to the many hydropower projects, fisheries and other anthropogenic activities, there is an environmental threat to this ecosystem[6]. At present, the lake is facing serious ecological problems, viz. cultural eutrophication, siltation and pollution. The construction of the Ithai barrage without proper planning has led to dams in the lake, resulting in uncontrolled proliferation of Phoomdi, thus reducing the open lake area. This has blocked the migratory pathways of a number of fish species and degradation of catchment areas[10]. Thus, owing to versatility of this natural habitat of diverse groups of micro and macroflora, there is an urgent need for conservation of this fragile ecosystem. The life of thousands of people living in this area is dependent of the lake itself. The destruction of this lake will ultimately result in the loss of natural habitat for birds, fishes, wild animals, livelihood and also industrially and agriculturally important microbes. Most importantly, sustainable use of the resources is the only option to conserve the Loktak Lake.

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ACKNOWLEDGEMENT. This work is supported by SERB-DST Fast track Young Scientist Project, Science and Engineering Research Board – Department of Science and Technology (SERB-DST).

Received 5 March 2018; revised accepted 11 April 2018

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Uranium mineralization in metasediments of North Delhi Fold Belt of Buchara area, Jaipur district, Rajasthan, India

The Proterozoic Delhi Supergroup rocks of North Delhi Fold Belt (NDFB) is one of the prime targets for base metals, uranium and other economic mineral prospects[1]. Intensive exploration by the Atomic Minerals Directorate for Exploration and Research (AMD) has identified uranium mineralization in Khetri sub-basin of NDFB[2,3]. Geological and radiometric survey for uranium exploration has resulted in locating significant radioactivity from uranium around