Procaryotes in Paris: does eutrophication or seasonal dynamics shapes gene- and taxa-contents of peri-urban lakes microbiome the most?

Pierre Foucault*[1,2], Sébastien Halary[3], Charlotte Duval[4], Midoli Goto[5,6], Sahima Hamlaoui[7], Benjamin Marie[4], Ludwig Jardillier[8], Dominique Lamy[9], Emilie Lance[3,10], Laure Cordier[11], Emmanuelle Raimbault[11], Fayçal Allouti[12], Marc Troussellier[13], Cécile Bernard[14], Sébastien Duperron[3], and Julie Leloup[15]

[1]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[2]Sorbonne Université, UMR 7618 CNRS-INRA-IRD-Univ. Paris Cité-UPEC, Institut d'Écologie et des Sciences de l'Environnement de Paris (iEES-Paris), Paris, France – Centre National de la Recherche Scientifique - CNRS, Institut National de la Recherche Agronomique - INRA, Institut de recherche pour le développement [IRD], Université Paris-Est Créteil Val-de-Marne (UPEC), Université Paris Cité, Sorbonne Université UPMC Paris VI – France

[3]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[4]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[5]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[6]MARine Biodiversity Exploitation and Conservation - MARBEC – Centre National de la Recherche Scientifique - CNRS – France

[7]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[8]Université Paris-Saclay, IDEEV, ESE – AgroParisTech, Université Paris-Saclay, Centre National de la Recherche Scientifique – bat. 362 91405 ORSAY CEDEX, France

[9]Sorbonne Université, UMR 7618 CNRS-INRA-IRD-Univ. Paris Cité-UPEC, Institut d'Écologie et des Sciences de l'Environnement de Paris (iEES-Paris), Paris, France – Université Paris-Est Créteil Val-de-Marne (UPEC), Centre National de la Recherche Scientifique - CNRS, Université Paris Cité, Institut national de la recherche agronomique (INRA), Institut de recherche pour le développement [IRD], Sorbonne Université UPMC Paris VI – France

[10]UMR-I 02 SEBIO Reims 51100 – Université de Reims - Champagne Ardenne – France

[11]Institut de Physique du Globe de Paris – Institut National des Sciences de l'Univers, Université de la Réunion, Institut de Physique du Globe de Paris, Centre National de la Recherche Scientifique, Université Paris Cité – France

[12]Muséum National d'Histoire Naturelle, UAR 7200 MNHN, Acquisition et Analyses de Données pour l'Histoire naturelle (2AD), Paris, France – Muséum national d'Histoire naturelle, UAR7200 A2D, 75005 Paris, France – France

[13]MARine Biodiversity Exploitation and Conservation - MARBEC – Centre National de la Recherche Scientifique - CNRS – France

[14]Molécules de Communication et Adaptation des Micro-organismes, UMR 7245 CNRS/MNHN Paris, France – Muséum national d'Histoire naturelle, CNRS, UMR7245 MCAM, 75005 Paris, France, Centre National de la Recherche Scientifique - CNRS – France

[15]Sorbonne Université, UMR 7618 CNRS-INRA-IRD-Univ. Paris Cité-UPEC, Institut d'Écologie et des Sciences de l'Environnement de Paris (iEES-Paris), Paris, France – Centre National de la Recherche Scientifique, Institut national de la recherche agronomique (INRA), Institut de recherche pour le développement [IRD], Université Paris-Est Créteil Val-de-Marne (UPEC), Université Paris Cité, Sorbonne Université UPMC Paris VI – France

Résumé

Lakes represent less than 3% of terrestrial surface on Earth. Yet, they constitute a reservoir of biodiversity and provide major ecosystem services, notably by their crucial role in the carbon and other nutrients cycles and as important drinkable and uses resources of water. They are also considered as sentinels of climate changes they integrate inputs from surrounding terrestrial ecosystems. Human activities have amplified natural (seasonal) variations of the environment and amplify natural phenomena, such as eutrophication (allochthonous inputs of nutrients), leading to major changes in lake ecosystems functioning worldwide. Eutrophication has been shown to be a major driver of aquatic microbial communities, key contributors to ecosystem functioning, at various spatial and temporal scales. Yet, the interaction between these scales and the impact on microbial community function, more than taxa, changes remain poorly investigated. With 12 million inhabitants, the Greater Paris offers a natural laboratory to explore the effects of eutrophication on freshwater lakes within a relatively restricted area. Here, a time-series was carried out during 18 months, to monitor planktonic microbial communities of nine lakes located within a 70 km radius around Paris (Île-de-France, France) with distinct trophic status (mesotrophic to hypereutrophic). During summer, lakes displayed major differences in prokaryotic taxa and functions despite their comparable morphologies. Trophic status was the main driver of the community structure and functional potential during the summer season (when the primary production peaks). Functional potential appeared much more stable than taxa composition within each lake, most of it being shared among all lakes. Phosphorus related processes contributed more than other BGC metabolisms to the difference between trophic statuses. Hypereutrophic lakes prokaryotic communities display the highest distinctiveness and heterogeneity over time, suggesting an alternative regime compared to lakes of lower trophic status. High eutrophication levels are sometimes assumed to be irreversible, so whether their driving effect and the hypothetical "regime shift" in hypereutrophic lakes continue in periods of lower primary production are being investigated. Besides, the identification of one lake dominated by non-bloom-forming Cyanobacteria over time without clear explanation shows that trophic status alone cannot explain all observations, pointing to the need to extend the considered top-down and bottom-up approaches (microbial eukaryotes, zooplankton, additional abiotic variables) in future studies.

Mots-Clés: Eutrophication, microbiome, metagenome, freshwater ecology, time, series

*Intervenant