



Dynamics of nitrifying bacterial communities in the Seine river and estuary as affected by changes in the treatment of Paris wastewater : a comparison of 2001-2003 vs 2012-2013 periods

Najla Aissa Grouz (1), Gilles Billen (2), Josette Garnier (2), Benjamin Mercier (1), and Anun Martinez (1)

(1) UMR Metis 7619, University Pierre and Marie Curie, Paris, France (najla.grouz-jerbi@upmc.fr), (2) CNRS, University Pierre and Marie Curie, Paris, France

The major branch of the Seine river from the confluence with the Marne river to the entrance of the estuary is deeply affected by the release of wastewater from the huge Paris agglomeration. In the first years of 2000, the largest part of the effluents were still discharged at the Seine-Aval (Achères) treatment plant with only a standard, low residence time, activated sludge treatment, thus releasing a high ammonium load. NH_4 concentration as high as 7 mgN/l were frequently observed downstream from Paris agglomeration. Cébron et al. (2003, 2005) and Garnier et al. 2007 described in details how this massive reduced nitrogen concentrations triggered the growth of nitrifying bacteria, already present in the upstream Seine and Marne rivers, but also brought in large amount by the effluents of the wastewater treatment plant themselves. The decrease of ammonium concentration was slow, however, and was only completed 200 km downstream, in the upper estuarine area, where it causes a severe oxygen deficiency.

Since 2007, important changes occurred in the treatment of nitrogen in the Parisian wastewater purification plants. In 2007, the Seine-Aval plant treated up to 90% of the ammonium contained in wastewater through nitrification, and 30% of the total supply of nitrates is treated by denitrification. These modifications have of course favorably affected the water quality of the Seine river: ammonium concentrations are reduced by a factor of 5 and the area of oxygen depletion in the upstream estuary is no more observed. However, nitrites, still released in the effluents, are a matter of concern for the water quality of the Seine downstream from Paris.

Using measurements of potential microbial activities carried out with the same experimental protocol for the 2000-2003 and 2012-2013 periods, we here examine and model the dynamics of ammonium oxidizing and nitrite oxidizing microbial populations before and after the implementation of nitrification treatment of Paris wastewaters. We show that, although large amounts of ammonium oxidizing microbes are still released in large amounts with the treated effluents, they no longer grows up in the Seine water by lack of substrate in sufficiently high concentration. The same is true for nitrite oxidizing micro-organisms, which explains the slow disappearance of nitrites from the downstream sector of the Seine River.

The maximum turbidity zone of the downstream estuary acts as a concentrator of particulate material. The concentration of nitrifying bacteria observed there is therefore a good indicator of the development of nitrifiers in the downstream sector of the Seine. Comparison of the levels observed in the 2000-2003 period and in 2012 fully confirms our interpretation.

In August-September 2013, a dysfunction of the Seine-Aval treatment plant occurred, and large amounts of incompletely nitrified effluents were released, so that high ammonium concentrations were still observed in the river. Interestingly, the dynamics of nitrifying microbial populations recorded during this event, contrasted with that observed in the preceding months, and more closely resembled that observed ten year ago, before the implementation of the new treatment in the wastewater purification plant.