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Summary Postdoc study

Biological wastewater treatment efficiency and microbial community composition in a photobioreactor (PBR)

My research study at UNESCO-IHE Institute for Water Education during my stay consisted to conduct laboratory and experimental works and write scientific papers on biological wastewater treatment using algae bacteria consortium. I focused my work on the removal of ammonium from wastewater but also analyze the biological community (algae and bacteria) contributing to nutrient removal such as ammonium.

Laboratory works

Experiment on biological removal of ammonium

The experiment consisted of simulating municipal wastewater by artificial wastewater used for the cultivation of algae and bacteria for nitrogen uptake and nitrification. Algae and bacteria cells were cultivated using a photobioreactor (PBR). The results of the experiment showed that algae bacteria consortium is an efficient tool for ammonium and other nutrient removal from wastewater. The use of algae bacteria to treat wastewater is then becoming a promising biological method for domestic and industrial wastewater. Furthermore, the biomass can also be recover for biofuel production and fertilizer for farming.

Microbial community analysis

For microbial community analysis, three main activities were conducted:

Separation of algae from bacteria

During the experiment, centrifugation methods were used for algae and bacteria separation in order to estimate the proportion of each quantity in the mixed biomass. The knowledge of the composition can help control the ratio between algae and bacteria that can sometimes inhibit each other if the proportions are not well controlled.

Fluorescence In-Situ Hybridization

The technique has been applied to observe the species and groups composing the algae bacterial community in the Photbioreactor. Some fixatives were used and samples observed under a fluorescence microscope. Observations were done using separated and non-separated samples.

Flow cytometry cell counting and sorting

This technique was performed using a flow cytometer from UNESCO-IHE Institute of Water Education. Using the cytometer, algae and bacteria cells were able to be counted. The counting allow estimating the proportions of algae and bacteria based on the cell number.

Paper writing

Two papers are now in preparation on the topics:

- Microbial biomass separation strategies to improve mass balances over a microalgae-bacterial photobioreactor (PBR) treating artificial wastewater
- Biomass composition, cell size and shape, and activity test of algae and bacteria after a separation of consortium biomass in a PBR by density gradient centrifugation using percoll colloid

The first article is almost ready and will be submitted to “Bioresource technology” journal before leaving the institute end December 2016

The second article in preparation will certainly be finished when I am back home. I am expecting to submit it also to an international impacted journal on water research at the end of the first semester of 2017.

Abstract PhD thesis

Micro-algae communities in temporary ponds: interactions with environmental variables and tadpole assemblages (West Africa)

This study aims to know algae communities and their relationship with physico-chemical variables and tadpole assemblages in temporary ponds. Therefore, it concerns : the inventory of species in ponds following a North-south climatic gradient ; determine algal community structure in relation to the physico-chemical parameters of water, the climatic and anthropogenic gradients ; determine through an experimental approach the impact of tadpoles on algae communities in experimental tanks. This study has been conducted from 2007 to 2009.

Method of sedimentation after fixing algae was used to have final samples before observation in light microscope for the systematic inventory of micro-algae species (qualitative study). With the light microscope, species of algae have been identified using references to standard works. For a quantitative study, a numeration of individuals has been done by the counting chamber of Fuchs-Rosenthal. A clustering of sampling sites carried-out using the method of indicator species values in Pc-Ord program allowed to distinguish clusters and ecological groups of micro-algae in ponds. To know the relationship between taxonomical groups or ecological groups and physico-chemical parameters, a coupling has been done using methods of multivariate analyses (DCA and RDA). Univariate analyses have been also carried-out in order to notice the variation of algae richness.

The results show in general that community of algae is quite diversified in temporary ponds (more than 300 species recorded with a Sannon diversity index of sites going from 1 to 4 bits/individual). This diversity is specially, function to physico-chemical variables under the impact of climatic and anthropogenic gradients. Among physico-chemical variables, pH and transparency of water seem to be those that influence more the variation of algal communities' structure in ponds. Experimental approach shows that some species of tadpole can have important role in the regulation of algae richness in ecosystems they occur (ponds in the circumstances). These tadpoles affect richness of algae by grazing, filtering, feeding detritus but also by regulation within tadpole assemblages done by carnivorous ones.

Key words: Temporary ponds, micro-algae communities, physico-chemical variables, tadpoles, Burkina Faso, Bénin, Pendjari, soudanian zone, sahelian zone.