Deciphering the ecological importance of V-based nitrogen fixation in boreal ecosystems.

Nitrogen (N) is the primary element limiting primary production in boreal ecosystems. Biological nitrogen fixation (BNF) is the main process by which N enters into unmanaged ecosystems and thus plays a significant role on boreal ecosystem function and evolution. This reaction is catalysed by the enzyme nitrogenase (Nase) in few prokaryotes. Three isoenzymes of the Nase nitrogenases have been identified so far. Beside the canonical molybdenum dependent nitrogenase (Mo-Nase), present in all N$_2$ fixers, two additional isoenzymes have been reported; the vanadium dependent (V-Nase) and the iron-only dependent nitrogenase (Fe-Nase). The role of these alternative nitrogenases in natural habitats has been mostly overlooked, because they are found in communities that were not considered major contributors to N inputs. In recent years, BNF by mosses and lichens has captured the interest of the scientific community for its importance toward global N input in high latitude ecosystems. Within this context, it is imperative to characterise the role of alternative Nases in these biomes.

Here, I will present the result of a recent project aiming at deciphering the potential role of V-Nase on BNF in high latitude ecosystems (boreal and subarctic areas). Using samples of the ubiquitous cyanolichen Peltigera aphthosa collected all around the boreal area of the northern hemisphere, we established that V present all the characteristic of an essential micronutrient for BNF in this biome. Using a newly developed method for N$_2$ fixation, we also confirmed in vivo the observation made on purified enzymes in the 80’ that the V-Nase is more efficient than the Mo-Nase at reducing N under low temperature conditions.

Overall, our findings challenges the traditional view of Mo hegemony on N input and invite to re-evaluate the importance of alternative Nases in natural habitats. The exact conditions at which V comes at play, and the relative contribution of the V-Nase, compared to Mo-Nase, in boreal ecosystems remains to be fully elucidated.