Plants, do you want to harbor your own fertilizer factory?

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Nitrogen, the most abundant element in the atmosphere, makes up about 78% of the air in the form of dinitrogen gas. Meanwhile, nitrogen, as an essential component of proteins, amino acids and many more other important molecules, also exists in every supermarket, in a milk package, or in a loaf of freshly baked bread. One might never think about the connection between dinitrogen gas and products that people consume daily, but in fact, they are tightly connected by the global nitrogen cycle. Given that dinitrogen gas is extremely stable at room temperature, nitrogen fixation is essential to convert atmospheric nitrogen into active nitrogen containing compounds, such as ammonia and nitrate. Plants can then take up these nitrogenous compounds through their root systems, and consequently transfer nitrogen element to other organisms *via* the food chain. However, biosphere nitrogen is constantly lost to the atmosphere through denitrification, a process where certain microbes metabolize nitrate and as a result create dinitrogen gas, which makes nitrogen the element in the soil that most often limits plant growth. Therefore, nitrogen fixation is of tremendous importance to maintain the biosphere. Without nitrogen fixation, there would be no life.

The global nitrogen input from the atmosphere to the biosphere is based on three major processes: atmospheric, industrial and biological nitrogen fixation. Biological nitrogen fixation is a major contribution: it can contribute as much as 60% of the total nitrogen input. Biological nitrogen fixation can only be performed by some prokaryotes. Among these nitrogen-fixing bacteria, the symbiotic bacteria that life in plant root systems have gained particularly interest from the biologists because of their efficiency in providing plants with nitrogen. In exchange against photosynthetic products, the root-nodule inducing bacteria offer the host plants reduced nitrogen. The fixation of nitrogen is catalyzed by a complex enzyme system, the nitrogenase, which displays extreme sensitivity to oxygen and requires an efficient system of protection against oxygen. So, either the bacteria can only fix nitrogen under micro-aerobic conditions, or they have to provide an oxygen protection system for nitrogenase, or such a system has to be provided by their symbiotic host. *Frankia*, the nitrogen-fixing symbiont of actinorhizal plants like alder and hawthorn, is not only capable of fixing nitrogen in symbiosis, but also able to form specialized structures in which nitrogenase is protected from oxygen in the free-living state.

The fact that *Frankia* can protect their nitrogenase against oxygen on their own has gained my interest in studying whether this unique group of nitrogen-fixing bacteria could provide nitrogen to non-symbiotic important crop plants like rice, with the aim to ease the use of nitrogen fertilizer. The objective was to investigate whether *Frankia* could enter the roots of non-host plants at all – the first necessary step to colonize plant roots. Experiments were designed to visualize *Frankia* by cytological staining with dyes that colored *Frankia* in blue or black and therefore made them visible inside roots. The results indeed implied that *Frankia* was accommodated in roots of non-host plants, but further investigations are needed for a deeper understanding.

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