Functions of mangrove plants-roots and soil chemicals

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The soils of coastal areas in tropical and sub-tropical regions are often low in nutrients and therefore have low fertility. First, tidal fluctuations wash out considerable quantities of organic matter such as plant detritus into the ocean, leading to low nitrogen soils. Second, minerals necessary for plant growth, such as iron and phosphorus, tend to be adsorbed on soil particles and oxide complexes in tropical oxidized soils, and thus plants cannot uptake these immobilized minerals. Under such infertile growth conditions, how do mangroves get enough nutrients to correspond to their high productivity? This presentation focuses on functions of mangrove plants which are keys to the highly productive mangrove ecosystems-that is, what happens to soil chemical properties after mangrove plants colonize? In order to characterize mangrove ecosystems and provide scientific guidelines for their conservation, knowledge of their soil chemical properties is necessary, because these properties are the basis of the ecosystems.
When plant seeds germinate and start to grow, soil chemical properties are affected. It is known that plants excrete a variety of substrates that facilitate the availability of macro- and micronutrients in the root zone, by enhancing absorption of appropriate nutrients even under nutrient deficient conditions. For instance, organic acid exuded from plant roots, such as citrate and malate, are known to mobilize P from sparingly soluble Fe, Al and Ca phosphates. Therefore, greater amounts of nutrients such as P and Fe are sometimes observed in a plant root zone compared with the bulk soil. Besides root exudates, plant roots continuously provide organic matter such as decaying root parts. These organic matter-rich root zones are different from the bulk soil and provide niches in which bacteria thrive, because heterotrophic bacteria can use these plant-derived carbon compounds as electron donors to generate energy. Therefore, soil microbial metabolic processes also change in association with plant colonization.
So far, root exudates from four mangrove species (*K. obovata, B. gymnorrhiza, E. agallocha* and *H. fomes*) have been characterized. In field work, there are some reports that Fe^{2+} concentration in mangrove soil pore water is positively correlated with live root density. These observations indicate that mangrove roots lead to enhanced Fe mobilization. We conducted a pot experiment and found that *A. marina* has high ability to move Fe and P in soil pore water, suggesting that mangrove roots provide Fe- and P-solubilizing substrates. In the pot experiment, we also found that three mangrove species (*A. marina, R. stylosa* and *B. gymnorrhiza*) have a function to enhance soil nitrogen content. During the six months' cultivation period, amounts of nitrogen in the mangrove soils increased four times more than in uncolonized soil. At the end of the cultivation, bacterial nitrogen fixation was significantly higher in the mangrove soil than in uncolonized soil, leading to an interpretation that the mangrove plants induced nitrogen fixing bacteria around them.
These self-supporting abilities observed in mangroves could be key functions so that they can form highly productive ecosystems even under sterile environments. There are more functions in mangroves that we do not yet know, so there is much more to discover.

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