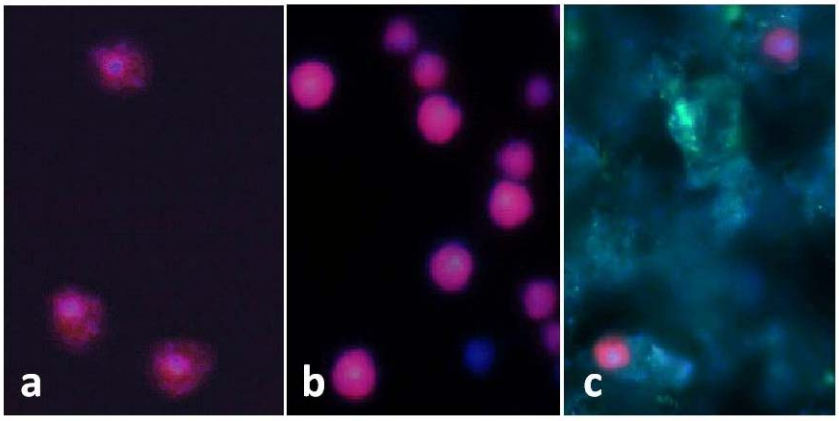
Interactions of microbes in terrestrial systems

Initial studies on terrestrial systems focused on aquifer material that was analyzed for the significance of toluene-degrading isolates in diesel fuel contaminated aquifer material, for diesel fuel mineralization under methanogenic conditions as well as for interactions between bacteria and protozoa. Diversity and dynamics of microbial communities in natural and contaminated soils were subsequently studied at different levels of resolution. DNA reassociation and % G+C DNA content profiles were used for a characterization on the community-level, indicating, for example, that heavy metal contamination leads to shifts in microbial community structure and a reduction of total microbial diversity. Profiling techniques such as ARDRA analysis and filter- and *in situ* hybridization techniques provided suitable tools for a coarse-level characterization of larger phylogenetic groups of organisms. *In situ* hybridization revealed the abundance in soil of yet uncultured bacterial populations in numbers that by far exceeded those of all bacteria usually detected by growth-dependent protocols. Comparative sequence analysis was used for a fine level characterization. Most reliable results in the analysis of microbial community structure and diversity, however, required multi-level analyses.



Vegetative cells (a), and cysts (b, c) of *Acanthamoeba* sp. in pure culture (a, b) and in soil (c)

Multi-level analyses were used in field and green-house studies on the interaction between microorganisms (i.e. bacteria, mycorrhizae, protozoa) and plants (*Spartina patens*) in estuarine environments investigating plant growth performance as a function of complex interactions between physicochemical parameters of the soil and the synergistic relationships among plants, fungi and bacteria. These studies also evaluated the usefulness of *S. patens* in phytoremediation of heavy metal- or petroleum hydrocarbon-contaminated environments, and analyzed their interaction with microorganisms under these conditions.

Selected publications

1. **Welsh, A.K., Burke, D.J., Hamerlynck, E.P., Hahn, D.** 2010. Seasonal analyses of arbuscular mycorrhizae, nitrogen-fixing bacteria and growth performance of the salt marsh grass *Spartina patens*. Plant and Soil 330, 251-266

2. **Welsh, A., Burke, D.J., Hahn, D.** 2007. Analysis of nitrogen-fixing members of the ε-subclass of Proteobacteria in salt marsh sediments. Applied and Environmental Microbiology **73**, 7747-7752.

3. **Suntornvongsakul, K., Burke, D.J., Hamerlynck, E.P., Hahn, D.** 2007. Fate and effect of heavy metals in salt marsh sediments. Environmental Pollution **149**, 79-91.

4. **Suntornvongsakul, K., Burke, D.J., Hahn, D.** 2007. Uptake and translocation of heavy metals in salt marsh sediments by *Spartina patens*. Bulletin of Environmental Contamination and Toxicology **78**, 275-279.

5. **Hahn, D., Cozzolino, A., Piccolo, A., Armenante, P.M**. 2007. Reduction of 2,4-dichlorophenol toxicity to *Pseudomonas putida* after oxidative incubation with humic substances and a biomimetic catalyst. Ecotoxicology and Environmental Safety **66**, 335-342.

6. **Burke, D., Hamerlynck, E., Hahn, D.** 2003. Interactions between the salt marsh grass *Spartina patens*, arbuscular mycorrhizal fungi and sediment bacteria during the growing season. Soil Biology & Biochemistry **35**, 501-511.

7. **Burke, D., Hamerlynck, E., Hahn, D.** 2002. Interactions among plant species and microorganisms in salt marsh sediments. Applied and Environmental Microbiology **68**, 1157-1164.

8. **Burke, D., Hamerlynck, E., Hahn, D.** 2002. Effect of arbuscular mycorrhizae on soil microbial populations and associated plant performance of the salt marsh grass *Spartina patens*. Plant Soil **239**, 141-154.

9. **Bolliger, C., Schönholzer, F., Schroth, M.H., Hahn, D., Bernasconi, S., Zeyer, J.** 2000. Characterization of intrinsic bioremediation by a combined analysis of ground water chemistry, stable carbon isotope ratios and microbial populations in a petroleum contaminated aquifer. Bioremediation Journal **4**, 359-371.

10. **Hesselmann, R.P.X., Werlen, C., Hahn, D., van der Meer, J.R., Zehnder, A.J.B.** 1999. Enrichment, phylogenetic analysis and detection of a bacterium performing enhanced biological phosphate removal in activated sludge. Systematic and Applied Microbiology **22,** 454-465.

11. **Sandaa, R.-A., Torsvik, V., Enger, Ø., Daae, F.L., Castberg, T., Hahn, D.** 1999. Analysis of bacterial communities in heavy metal contaminated soils at different levels of resolution. FEMS Microbiology Ecology **30,** 237-251.