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BIOREMEDIATION AS A POTENTIAL ALTERNATIVE FOR SOILS OF EACF CONTAMINATED WITH PETROLEUM HYDROCARBONS

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Natural environments have been affected by oil spills around the world for decades. In some cases, the attempt to cleanup can be made using physical and chemical methods. However, for the Antarctic environments this is not so simple. Displacement of the machinery necessary for the application of physical methods would be very expensive whereas the application of chemical methods would be dangerous considering the risks of additional environmental impacts.

Bioremediation techniques are relatively more cost-effective and benign.

This technique is based on the ability of some microorganisms (especially some bacteria) to use the petroleum hydrocarbons as energy source. Considering the low-risk, the best cost-effective choice to be applied in oil-contaminated sites, presenting high rates of hydrocarbon degradation, is the monitored natural attenuation. However, in some cases, environmental factors can cause the recalcitrance of the pollutant. The more frequent cause of recalcitrance is the depletion of nutrients (especially N and P) due to input of large quantities of carbon sources (petroleum hydrocarbons). An alternative to overcome this problem is the addition of fertilizers (e.g. N-P-K, MAP, DAP). This technique is known as biostimulation. However, some precautions must be taken. For the biostimulation the most important aspect is to avoid the excess of fertilizer, which could cause side effects like eutrophication.

Temperature is a critical factor for bioremediation success. In Antarctic soils, low temperatures can decrease the rate of biodegradation even when nutrients are available in satisfactory concentrations. An alternative to overcome this difficulty is to increase the number of cells of a consortium of degraders in artificial mediums under conditions of optimum growth before the introduction in nutrient-amended polluted soils. This technique is known as bioaugmentation.

Theoretically, bioaugmentation is a more promising technique than biostimulation. However, the effectiveness of bioaugmentation is variable due to the low rates of survival and degrading capability of introduced microorganisms. Furthermore, in Antarctic soils the implementation of this technique is not feasible since the introduction of alien species should be avoided. An alternative to overcome these difficulties is to introduce indigenous microorganisms capable of degrading oil to the contaminated site.

The purpose of the work that is being implemented is to test different doses of fertilizer in microcosms and mesocosms and to isolate and cultivate microorganisms

that use petroleum hydrocarbons as C source. During the microcosms and mesocosms experiments, the physical-chemical characteristics of soil, content of TPHs (total petroleum hydrocarbons) and biological changes based on molecular approaches will be determined. Autochthonous microorganisms capable of growth in mediums containing petroleum hydrocarbons as sole C source will be selected during the isolation and cultivation experiments. The obtained isolates will be characterized and stored. Based on the results of these preliminary studies, the possibility of implementation of a bioremediation process in contaminated soils around the Brazilian Antarctic Station Comandante Ferraz (EACF) will be evaluated.

Molecular approaches will be used to characterize microbial structures of the contaminated soil before and during the preliminary studies, allowing us to monitor the changes caused by bioremediation processes on the microbial diversity. PCR-DGGE (denaturing gradient gel electrophoresis) technique can be used to determine changes of microbial structures whereas cloning and sequencing techniques can be used to characterize the taxonomic and functional diversity of soil under different treatments based on marker genes, in addition to the characterization of the obtained isolates.

Oil contamination of soils of EACF was caused by a tank rupture in the mid eighties in addition to little spills and intense use of motor vehicles. In some sites the presence of oil can be visually detected, which leads us to believe that a monitored natural attenuation is not feasible. Soil samples of the diesel contaminated area around the EACF were collected in March 2010 and transported to the Laboratory of Molecular Microbial Ecology of the Federal University of Rio de Janeiro. We are performing experiments on microcosms testing different fertilizers concentrations on soil of EACF with variable levels of contamination. Based on the results of these experiments, an in situ mesocosm experiment will be installed in the EACF area to evaluate the feasibility of the implementation of a biostimulation- and/or bioaugmentation-based bioremediation strategy for the contaminated sites. During all the experiments samples will be collected, processed and stored for physical-chemical and microbiological characterization and determination of the content of TPHs.