Phosphatase activities in soils sampled near Showa Base, Antarctica

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The frontier of terrestrial biosphere is enlarging. A number of techniques are proposed to evaluate biological activities in extreme environments including cultivation methods, assay of metabolism, and analysis of bioorganic compounds like amino acids and DNA. Enzyme activities are useful signature of extant life in extreme environments. Among many enzymes, phosphatase could be a good indicator of biological activities, since phosphate esters are essential for all the living terrestrial organisms. In addition, alkaline phosphatase is known as a typical zinc-containing metalloenzyme and quite stable in environments.

Antarctica surface environments are quite severe environments for life since it is extremely cold and dry and exposed to strong UV and cosmic rays. We tried to evaluate biological activities in Antarctica by measuring phosphatase activities. Surface soil samples are obtained at the Sites 1-8 near Showa Base in Antarctica during the 47th Japan Antarctic exploration mission in 2005-6. Activities of acid phosphatase (ACP) and alkaline phosphatase (ALP) are measured spectrophotometrically after mixing the powdered sample and p-nitrophenyl phosphate solution (pH 6.5 for ACP, pH 8.0 for ALP). ALP was characterized after extraction from soils with Tris-HCl buffer (pH 9.0), where the activity was measured fluorometrically with 4-methylumbelliferyl phosphate (pH 8.0) as a substance.

The soil of Site 8 (near a penguin rookery) showed almost the same level of ACP and ALP activities as usual surface soil sampled in YNU campus, while the soil of Sites 1-7 showed much less activities. ALP in the extract from the soil of Site 8 was characterized. It showed the maximal at 338 K, while ALP from the campus soil showed the maximal at 358 K. Gel filtration chromatography showed that the ALP activity was found only in the fraction whose molecular weights were over 60000. The ALP activity was diminished with EDTA and was recovered with addition of zinc ion.

The present results showed that zinc-containing metalloenzymes which had lower optimum temperature than those in usual environments are present in Antarctica soil. It was suggested that phosphatases are good bio-signatures for extant life in extreme environments.