The bacterial diversity of snow collected from Himalayan peaks: a study system for stratospheric transfer of microorganisms and colonization of extremely cold environments

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The high peaks of the Himalayan mountain range provide a number of permanently cold environments that are relatively pristine due to their remoteness and difficulty of access. Such habitats have been little investigated (e.g. see Segawa \textit{et al.}, 2005). Judicious selection of sampling sites can provide samples of snow that one can be reasonably confident contain microbiota that are derived by aerial transfer rather than by direct human or animal transfer at ground level. Due to their height, sites at or close to the peaks are one of the most UV-exposed locations on Earth and provide the opportunity to investigate effects of natural irradiation on microbial populations \textit{in situ}. In a collaborative study between atmospheric physicists and microbiologists, we have begun an investigation of the bacterial populations in snow collected from close to the peaks of three >8,000 metre high mountains in the Himalayan range. The following hypotheses will be addressed:

a) Snow populations reflect global aerial transfer, but may be influenced by local niche conditions,
b) High UV irradiance, plus low nutrient and water availability, will select for resistant populations,
c) Aerial transfer is a significant source of microbial propagules.

Thus far, we have samples from two peaks, with a third sampling planned for 2006. This presentation will give the results of samples collected on Mount Everest and the adjacent peak of Cho Oyu that is approximately 0.5 km up-prevaling-wind. Snow samples (200-400 ml) have been collected by mountaineers, including our scientific staff, under aseptic conditions using sterile scoops into sterile bags for return to base camp where the snow is melted slowly in the bag and filtered through 0.45 μm (for vegetative cells) or 0.22 μm (for spores) membrane filters and the filters stored in sterile plastic containers for cold transport back to UK for analysis using a combination of culture on a range of solid media (using dilute concentrations of nutrient sources) and phenotypic identification, including advanced phospholipid fatty acid (PLFA) analysis, and molecular cloning and identification by 16S rRNA sequence analysis.

Data collected so far demonstrate a limited bacterial diversity of cold adapted species of common genera, including \textit{Pseudomonas}, \textit{Alteromonas} and
Alcaligenes, with good agreement between the direct culturing and DNA approaches for identification. This limited diversity concords with the findings of Segawa et al. (2005), who reported a single psychrophile and two psychrotolerant bacteria in snow samples taken from considerably lower altitude (approx. 2,600 metres) in the Tateyama Mountains, Japan. Our talk will discuss new data comparing the biodiversity of two high peaks and discuss the implications for stratospheric transfer of bacterial propagules and the colonization of pristine cold environments at high altitude.

Reference: