# A strategy to protect reference sites for future microbiology research in Antarctica

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One tool of the Protocol on Environmental Protection of the Antarctic Treaty that could be specifically used to protect microbial habitats is the **creation of inviolate areas** where a special entry permit is required (inside ASPAs, for example) and quarantine equipment needs to be used. These zones could be set aside for future research and become extremely valuable *"as is"* after a few decades, they would be **unique examples of pristine habitats**, representative of the native microbial diversity and processes. Actual examples of this are ASPA 126, Byers Peninsula, and ASPA 172, Lower Taylor Glacier and Blood Falls.

**Antarctica is essentially a microbial continent.**
- Large biodiversity of adapted microorganisms lives permanently in the ice-free areas (about 44,000 km$^2$).
- Presence of potentially endemic taxa
- Survival in glacial refugia since the continent moved away from Australia and South America
- They show biogeographic patterns
- Antarctic microorganisms may contain novel molecules with potentially pharmaceutical or biotechnological interest

**Microbial habitats are under anthropogenic pressure**
New 'entry points' for microbial contamination (Chown et al. 2012)
- Due to human presence, non-indigenous microorganisms are released from bodies, clothing, cargo and food into the environment (Cowan et al. 2011).
- Increase of tourism and its diversification from coastal cruises to adventurous expeditions into the continent
- Increase of research stations and associated impacts

🔔 **Impacts** of such introductions are still unknown !
- ? loss of the native microbial biodiversity
- ? modification by horizontal gene transfer.

## Why do we need inviolate areas ?

**Microorganisms are generally invisible to the human eye**
-Need a microscope and relevant expertise to demonstrate their presence
- Need molecular methods to determine their identity.

**New sensitive High-Throughput analyses accessible**
- Constant progresses in molecular methods (NGS)
- Potential to describe the microbial communities with unprecedented details without preconceived expectations

🔔 Will there still be pristine Antarctic areas to study the native microbial flora, its functioning and properties?

**Microorganisms are largely ignored by The Protocol on Environmental Protection of the Antarctic Treaty**.
- Antarctic Specially Protected Areas (ASPA) to protect "*outstanding environmental, scientific, historic, aesthetic, or wilderness values, any combination of those values, or on-going or planned scientific research*" (http://www.ats.aq/e/ep_protected.htm).
- However, no systematic planning and general focus on the conservation of large animals or higher plant communities.
- Terrestrial habitats are protected in 55/72 existing ASPAs (in total less than 700 km$^2$), mostly based on the need to protect vascular plants and bryophyte communities (Shaw et al., 2014).
- In 28 ASPAs, the protection targets the lichens, whereas microalgae are protected in 16 ASPAs, cyanobacteria in 7 and snow microalgae in 3. Only 8 ASPAs mention 'Microbial habitats', 'microbial communities' or 'soil and lake microflora'.

Such an option would necessitate **discussions and consensus with scientists of other disciplines** to select these regions, and careful management protocols of the sites and their vicinity (Hughes et al. 2015). In addition, **gaps in knowledge** should be addressed, like the extent of transportation of microorganisms by natural means (winds, birds, microplastics biofouling...) (e.g. Pearce et al., 2009), and the probability of subsequent colonization of new areas by microorganisms coming from other Antarctic regions or from outside Antarctica.

Let's hope that the **dialogue between scientists and policy makers** will enable to improve the conservation of Antarctic microbial diversity and safeguard the possibility to study these unique communities in the future with the most advanced techniques of the time. The outcome of these discussions might also be of interest for **Arctic and alpine regions**.