Diversity and Structure of microbial communities in Fildes Peninsula, Antarctica

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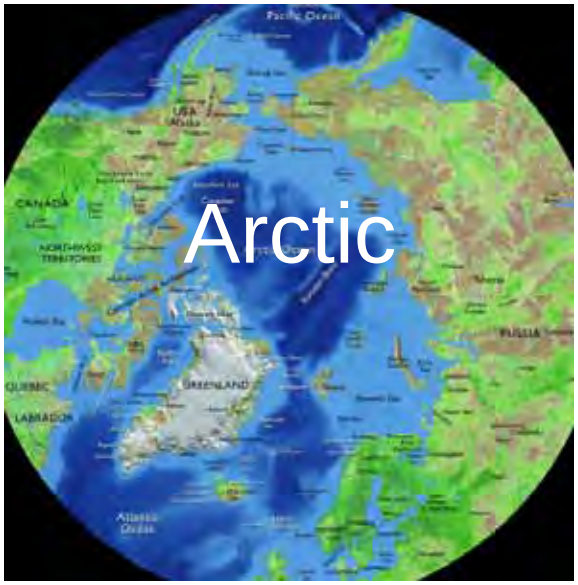
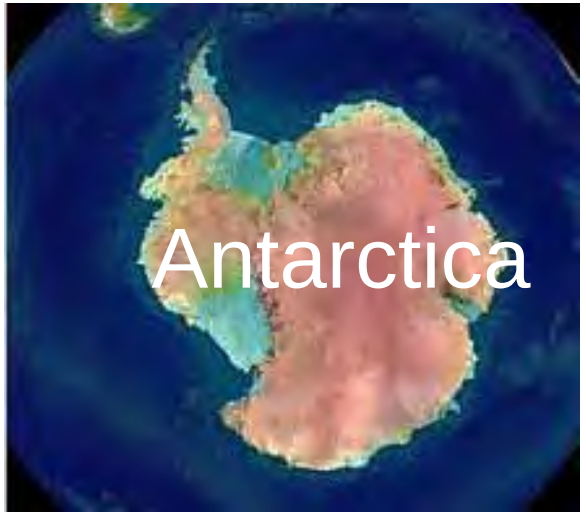
Polar- Arctic and Antarctica

- The Arctic encompasses a large, mostly frozen ocean surrounded by land. The Arctic is expected to experience the greatest rates of warming compared with other world regions (IPCC, 2007a). In part, this is because ice has greater reflectivity (also known as albedo) than the ocean or land.

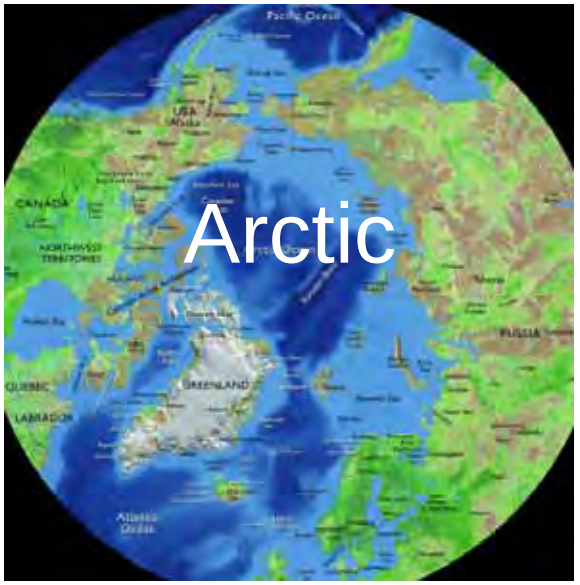


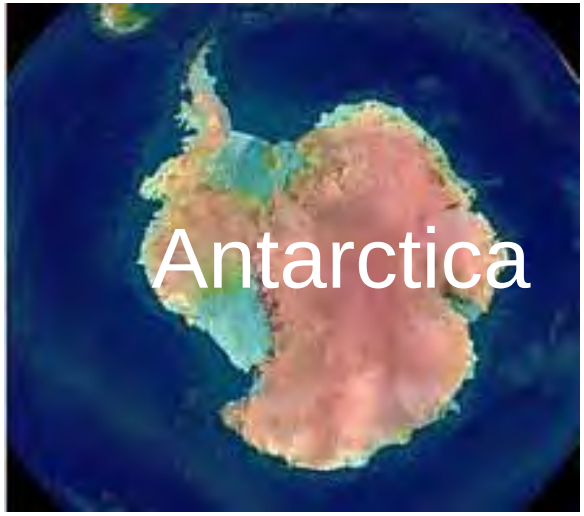
Antarctica is an ice-covered continent surrounded by ocean and is generally uninhabited.



Polar- Arctic and Antarctica

There is evidence that climate change is already having observable impacts in the Arctic and in Antarctica. Many of these observed changes are consistent with the expected effects of climate change under a range of climate scenarios.

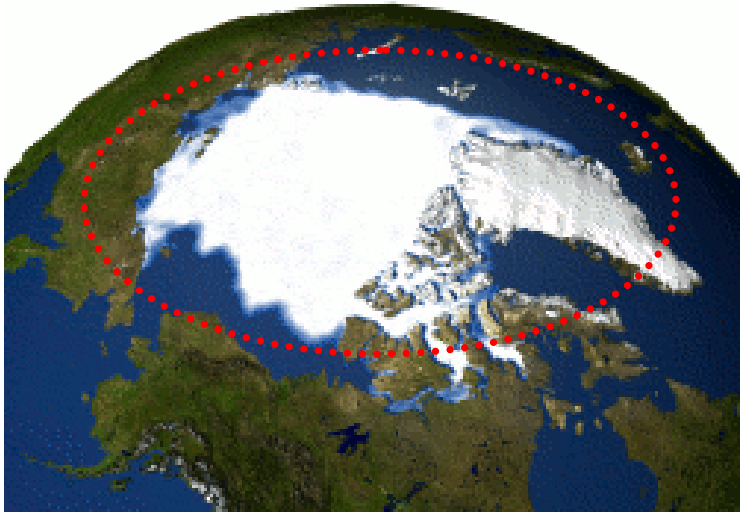




Antarctic and climate change

- The Antarctic is a critically important part of the earth system. The climate, physical and biological properties of the continent and the surrounding ocean are closely coupled to other parts of the global environment through both ocean and atmosphere circulation and CO_2 exchange.
- Antarctica contains 90% of the world's ice and 70% of the world's fresh water, which is enough to raise sea level by 63 m.
- It also holds high resolution records of past climate change and sensitive biological indicators of contemporary change.
- The Antarctic 'ozone hole' was one of the most significant scientific discoveries of the last century and it has had a profound impact on the Antarctic environment.

Arctic and Climate Change



Observed sea ice changes. This animation shows sea ice coverage shrinking from 1979 to 2005, by roughly half. (Source: NASA)

In the Arctic, sea ice is one of the most important climatic variables. It is a key indicator and agent of climate change, affecting surface reflectivity, cloudiness, humidity, exchanges of heat and moisture at the ocean surface, and ocean currents.

Polar, Microbial and Climate Change

- Polar persistently cold environments constitute one of our world's largest ecosystems, and microorganisms dominate the biomass and metabolic activity in these extreme environments . Many of the microorganisms that dominate these environments have special adaptations to tolerate stressful growth conditions.

- Climate change is altering the growth environment in Antarctica, and so selection pressures on these microorganisms are changing which, in turn, might affect microbial activity in key processes such as biogeochemical cycling.

So :

- In order to better understand the effects of climate (and its consequent environment) change on microorganisms in the polar, it is important to know the biodiversity, stability and function of microbial groups within an ecosystem.

- We need the data which can give an overview of the various types of bacterial groups that were present in different environment of polar.

Diversity and Structure of Microbial Communities in Fildes Peninsula, Antarctica

Antarctica is one of the largest and most pristine wilderness areas left on earth，in the virtual absence of plants, soils are microbially dominated ecosystems. Soil communities are regarded as among the most complex and diverse assemblages of microorganisms.



The terrestrial environment of the Antarctic Peninsula is dynamic, variable and a region of extreme habitats. The general climate data show that the mean annual temperature is relatively stable in the area of Admiralty Bay at about -2℃(located at King George Island).

Where is the Fildes Peninsula ?

King George Island ,which are part of the South Shetland Island, It is located south of Cape Horn, the south extremity of South America, and north of the Antarctic Peninsula.

Where is the Fildes Peninsula ?

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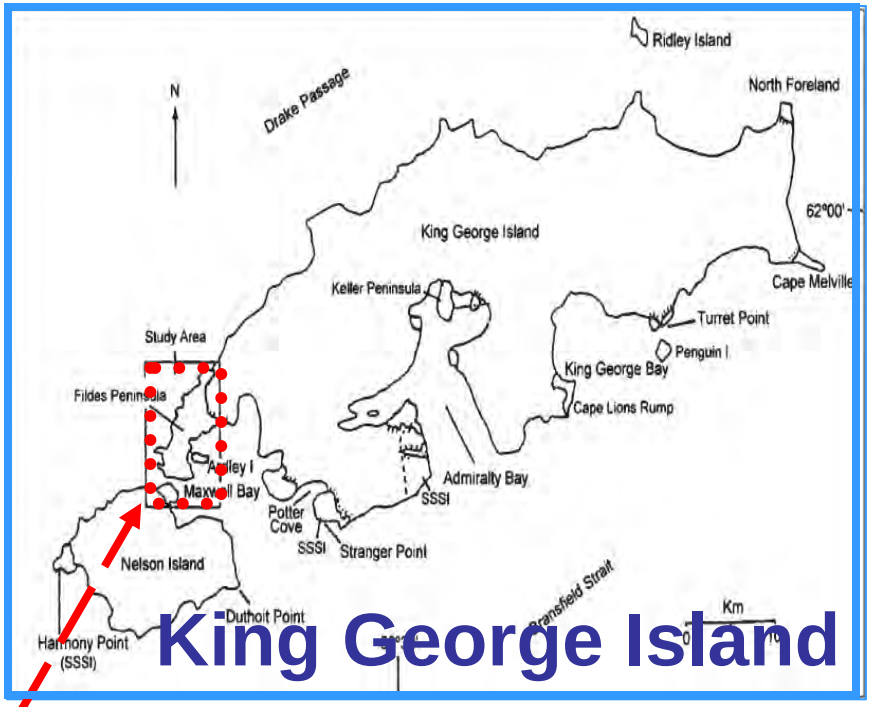
The Fildes Peninsula is the most extensive coastal area free of snow in summer in King George Island.



Samples were acquired from seventeen different stations of Fildes Peninsula in Antarctica during 2009.

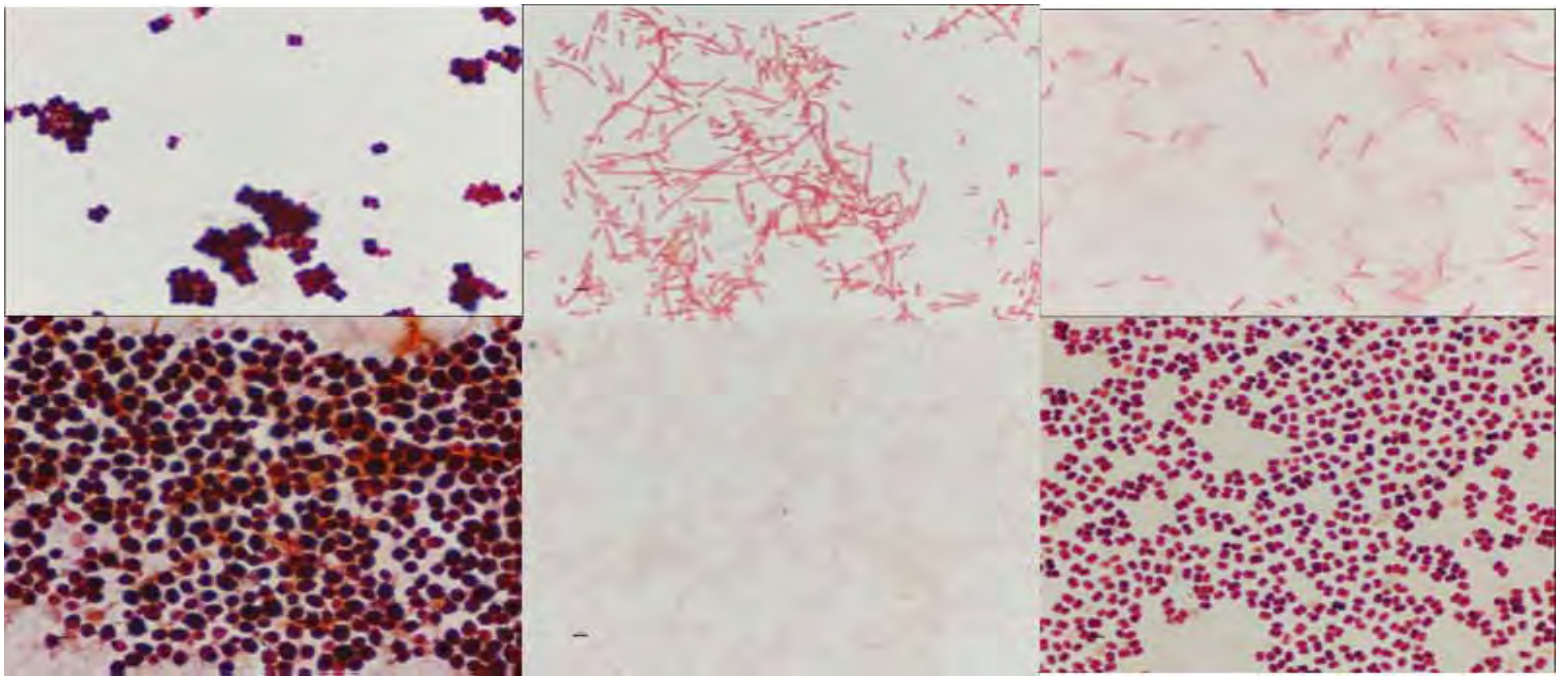
Samples

Samples included:

- **marine sediment**
- **lacustrine sediment**
- **penguin ornithogenic sediment**
- **soils**

Character of Cultured Bacteria

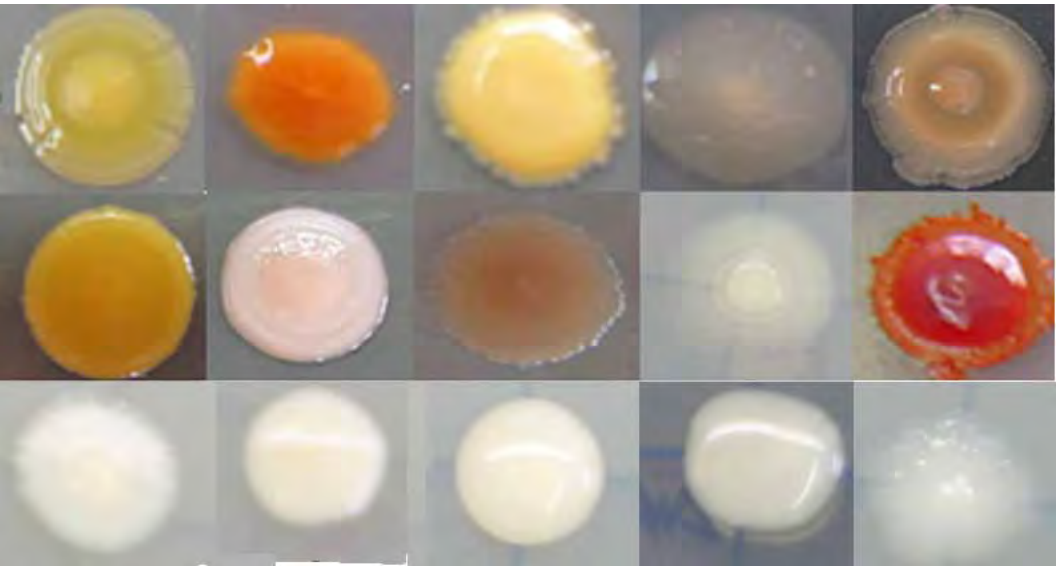
- Gram-staining investigations revealed that most isolates were Gram-negative.
- Some isolates were Less-common morphology .



Character of Cultured Bacteria

Pigmented colonies:

Many of the isolates formed pigmented colonies in agar plates.



Similar pigmented bacteria have also been observed in soils in King George Island, South Shetland Island group as well in the Arctic Svalbard Islands.

Character of Cultured Bacteria

Pigmented colonies:

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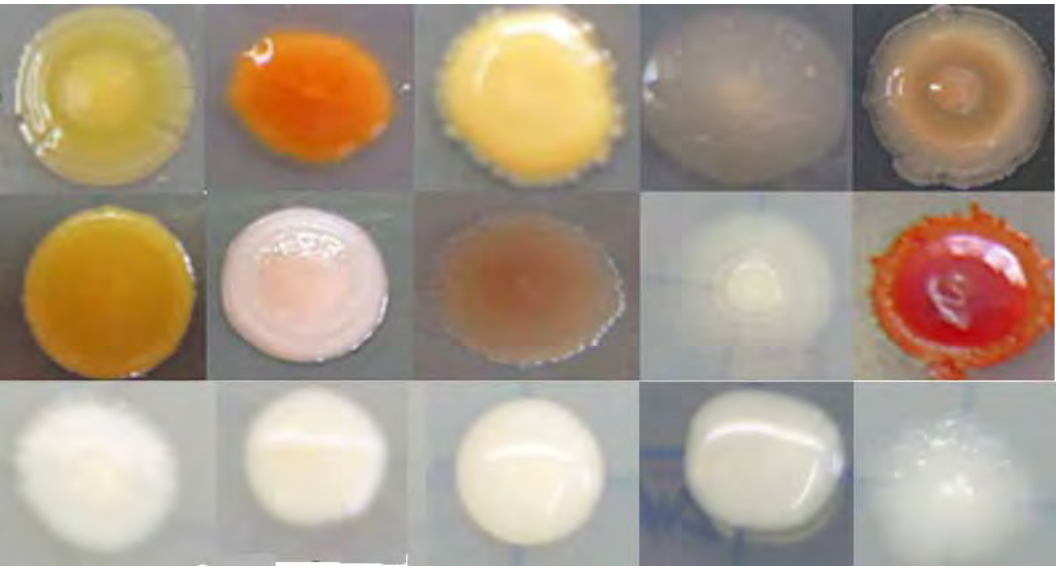
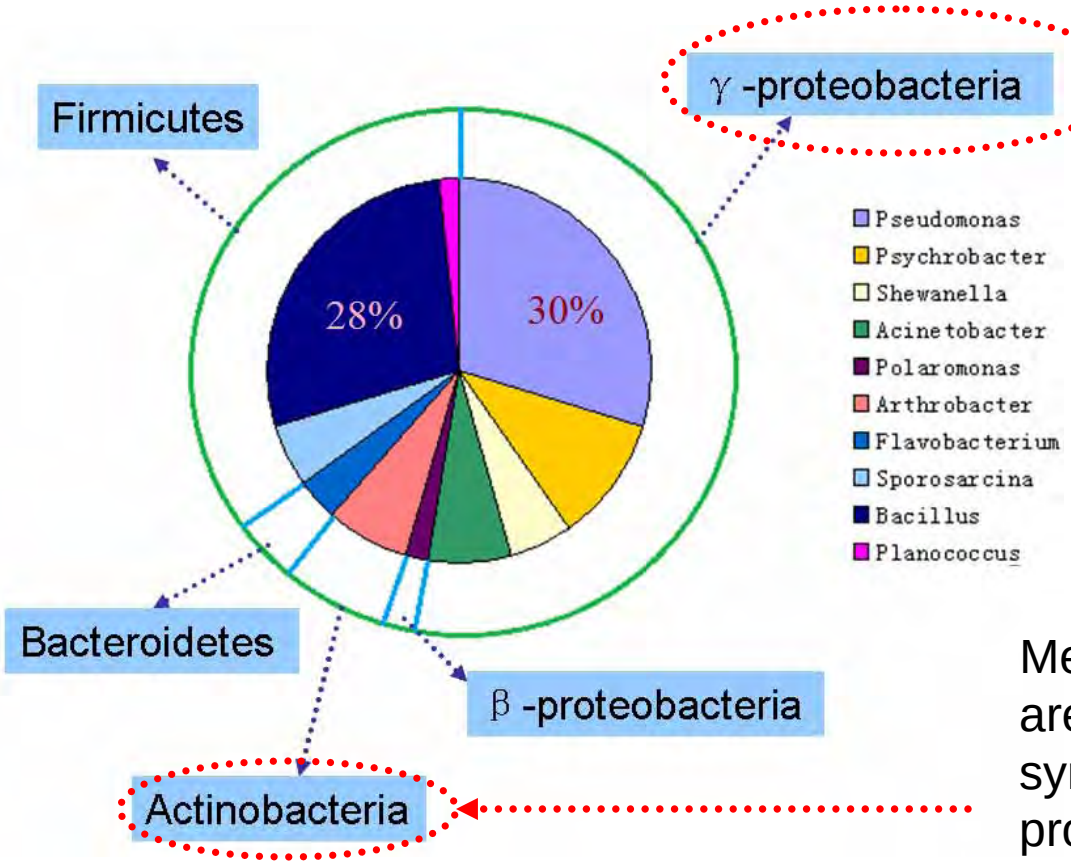


It appears that this type of bacteria commonly develop in cold desert ecosystems and is easily transported with aerosols at both, short and long distances.

Diversity of Cultured Bacteria

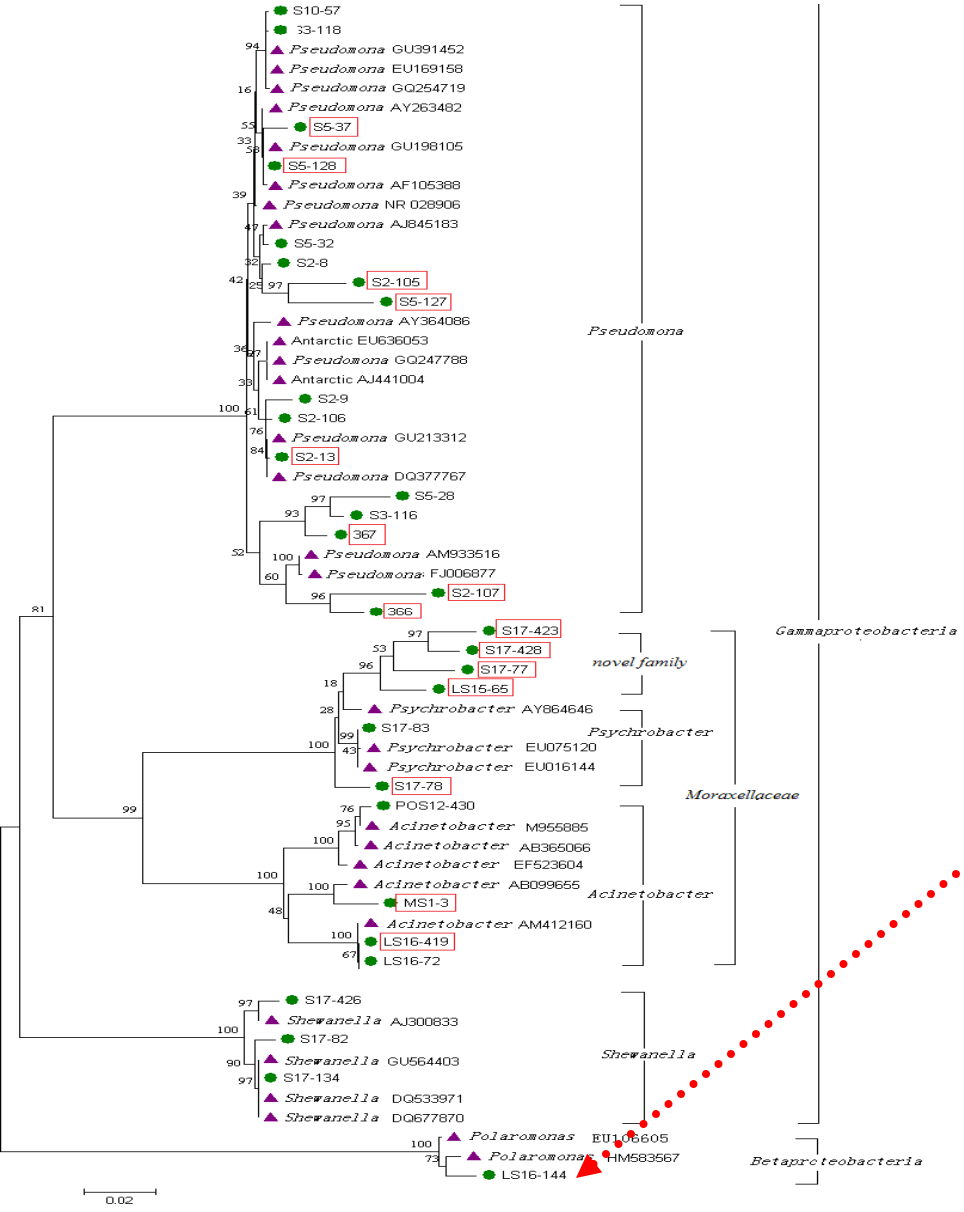
Screening of pure cultures and subsequent sequencing of representatives from each plates revealed that isolates distributed among 4 phylum (9 genus).



γ ***-Proteobacteria*** of the phylum were dominant bacteria

Members of the *Actinobacteria* class are well known for their ability to synthesize pigments for radiation-protection purposes

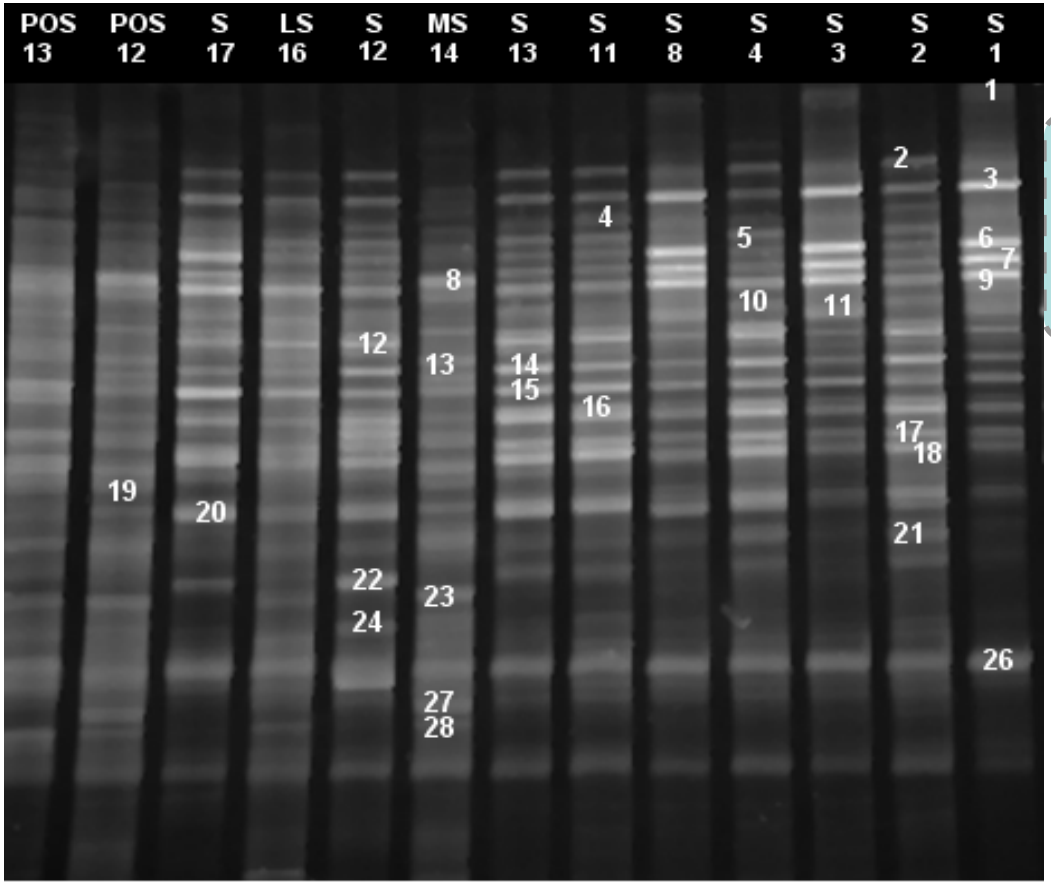
proteobacteria



16S rDNA sequencing results suggested that 16 of the isolates has the highest 93%-96% with the genus in the GenBank database, those isolates may represent new species.

Polaromonas which mostly be obtained from colder environment was only representment of β-proteobacteria

Diversity of Bacteria by DGGE



POS： Penguin ornithogenic ；

LS： Lacustrine sediment

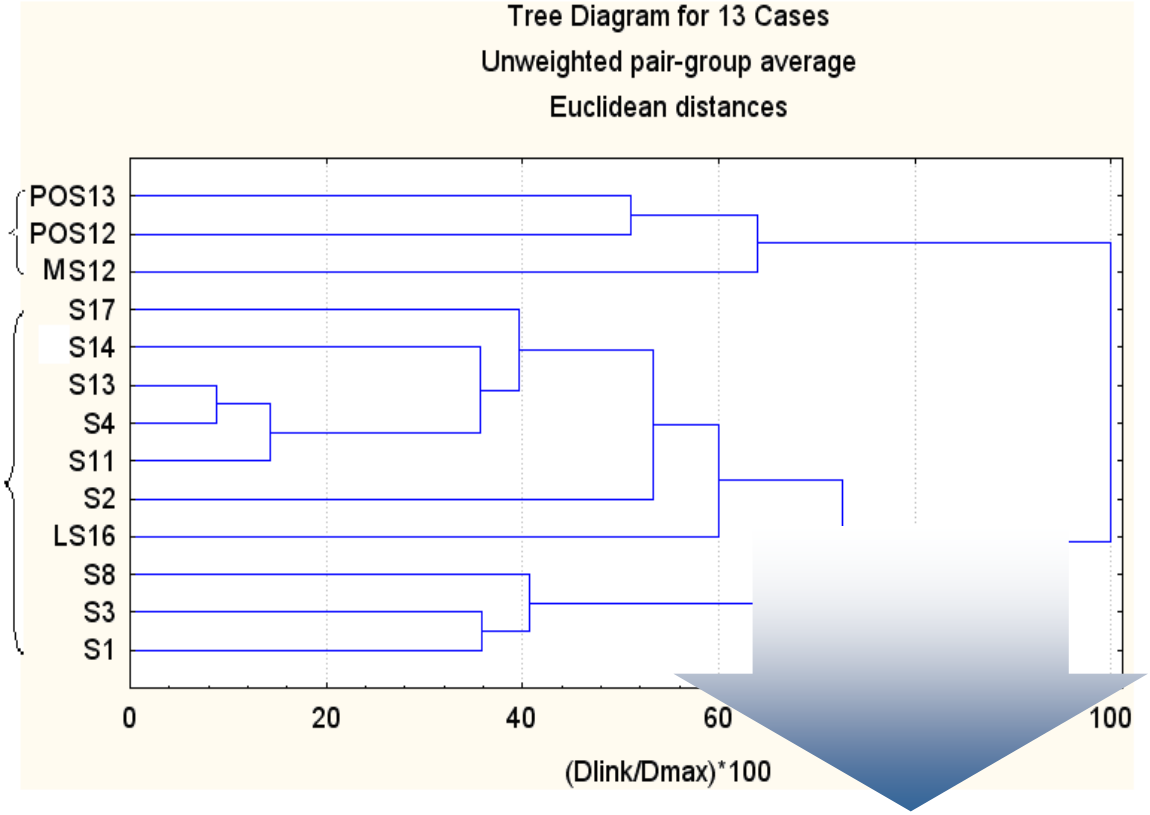
MS： Marine sediment　S ：Soil

Analysis of diversity

Sites	S 1	S 2	S 3	S 4	S 8	S 11	S 13	S 12	MS 14	LS 16	S 17	POS 12	POS 13
Shannon-Weaver (H)	2.52	2.82	2.69	2.72	2.79	2.72	2.65	2.65	2.85	2.83	2.66	2.56	2.69

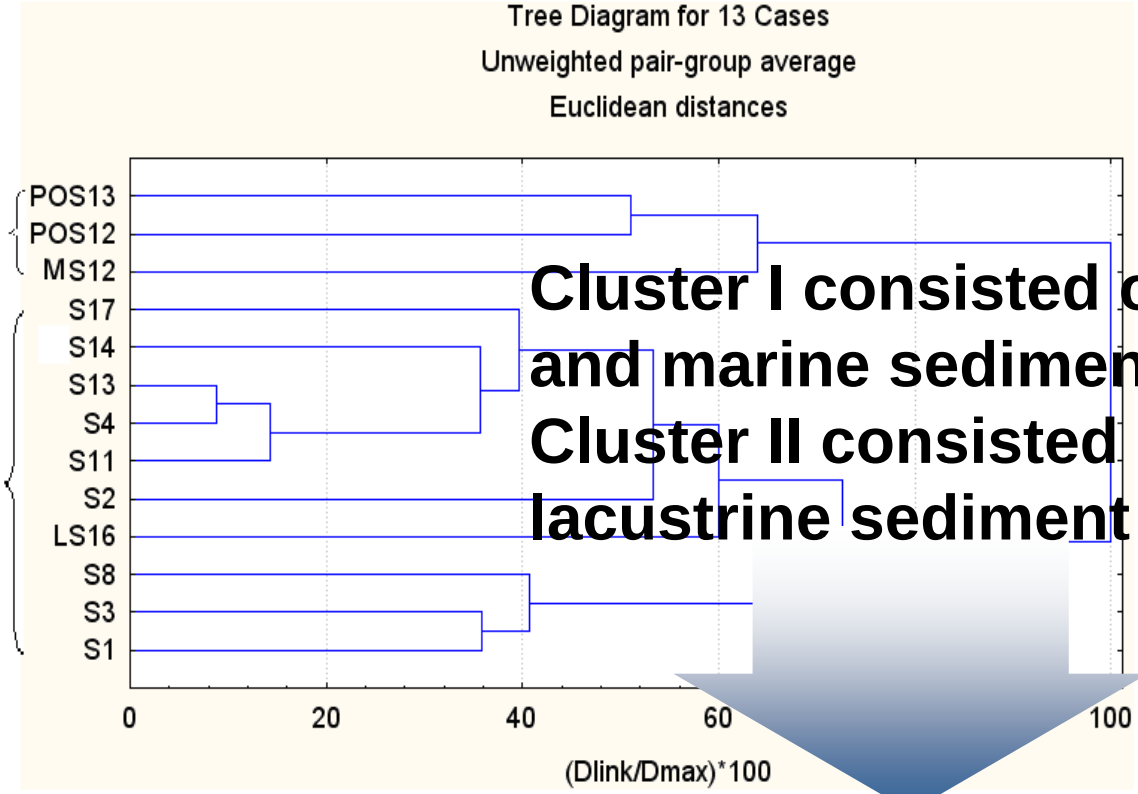
The band patterns of different samples reveal similar diversity .

Cluster Analysis



There were significant differences between Clusters I and II in the overall structure and composition of the bacteria.

Cluster Analysis

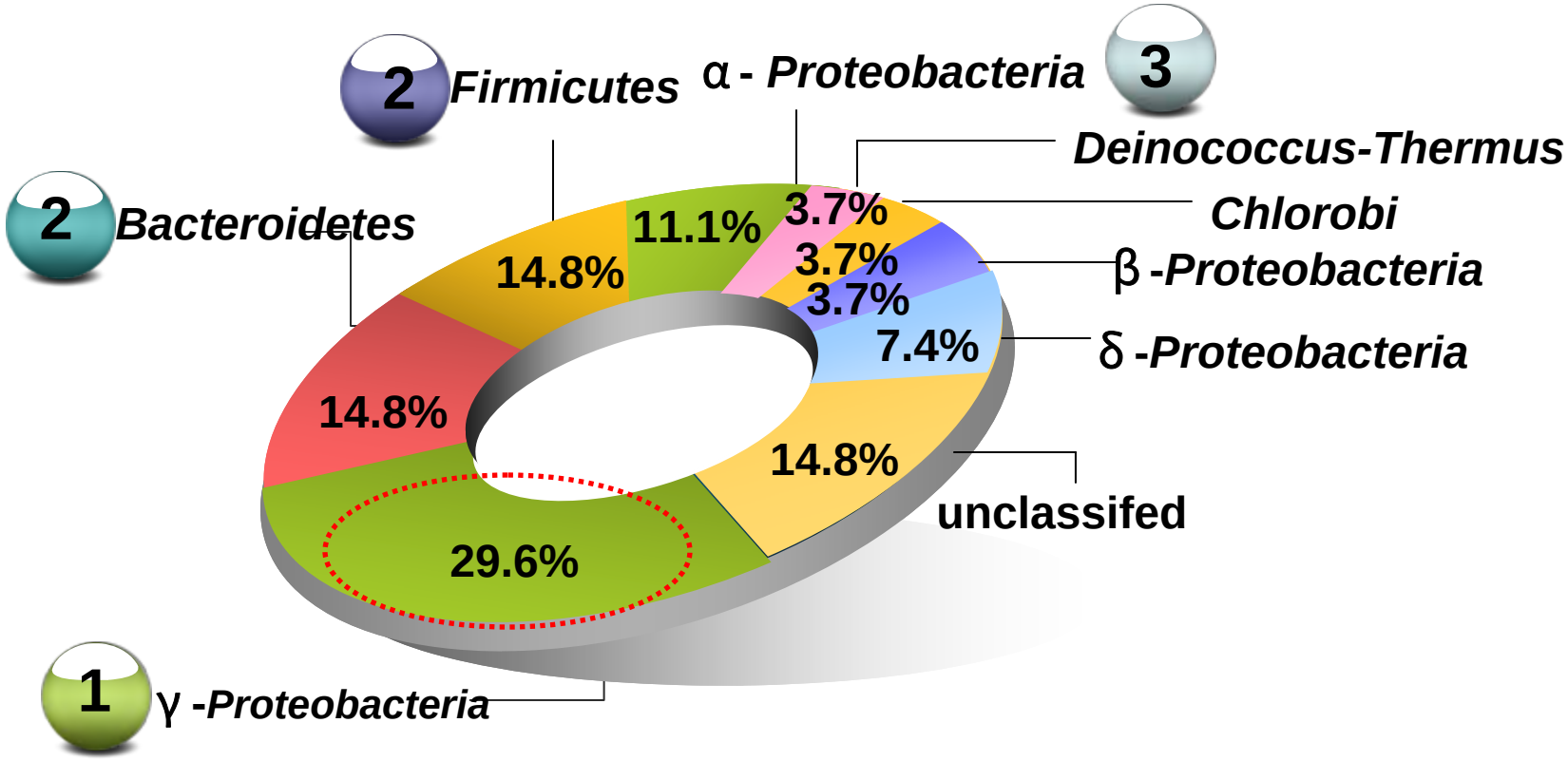


Cluster I consisted of penguin ornithogenic and marine sediments

Cluster II consisted of soil and lacustrine sediment samples

There were significant differences between Clusters I and II in the overall structure and composition of the bacteria.

Composition of the Bacterial Communities

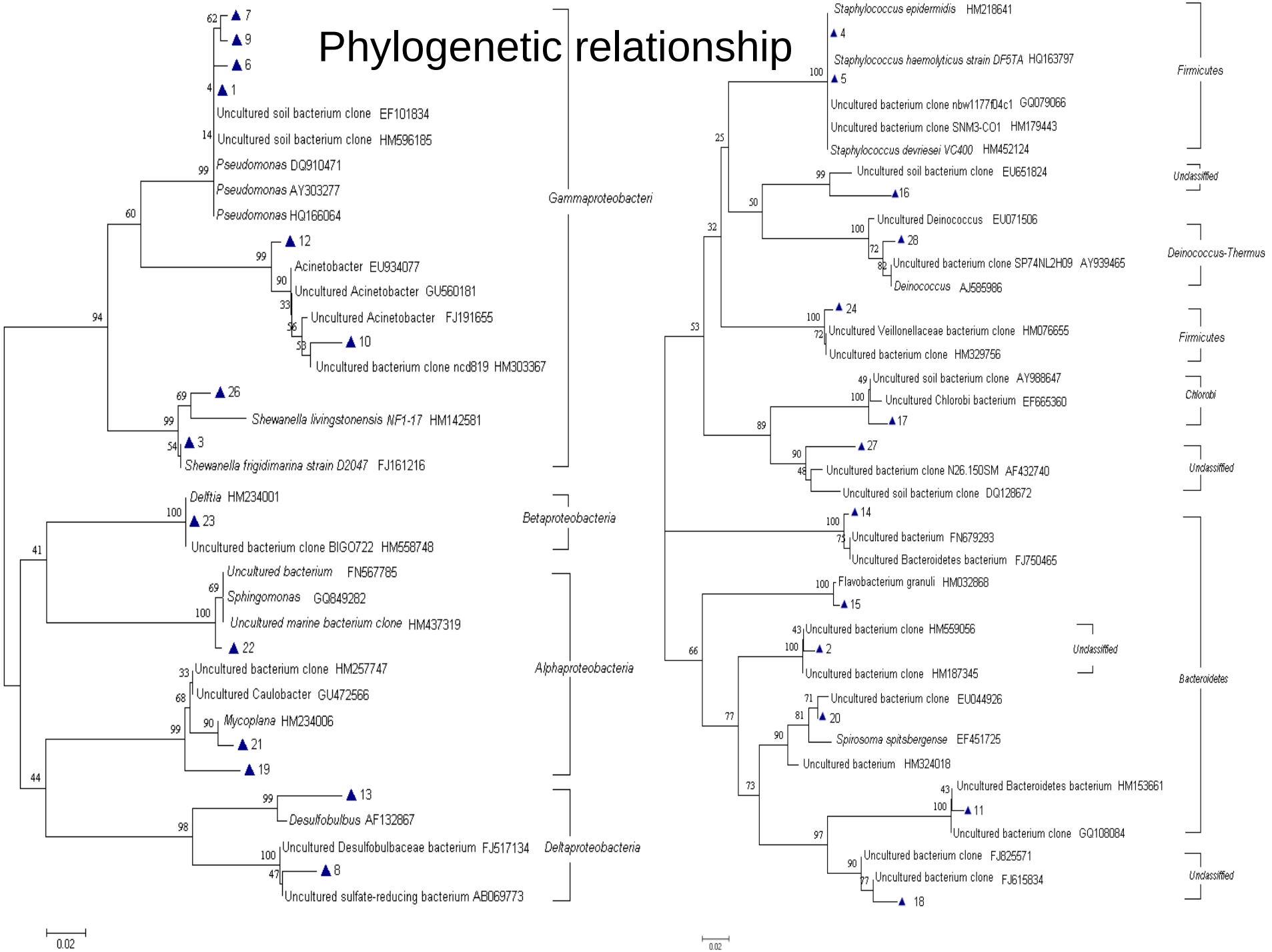


identity	source	Dominant
>97%	Polar or cold environment	γ -*Proteobacteria* *Bacteroidetes*

Bacteroidetes

This class is commonly found in Antarctica and has been reported to possess the ability to degrade a wide range of polymeric substances such as chitin and cellobiose. Members of the Bacteroidetes have been found to be prevalent in the intestine and faeces of mammals (Dick and Field 2004; Flint et al. 2007), and members of Flavobacteriaceae are prominent during the early stages of guano decomposition (Zdanowski et al. 2004).

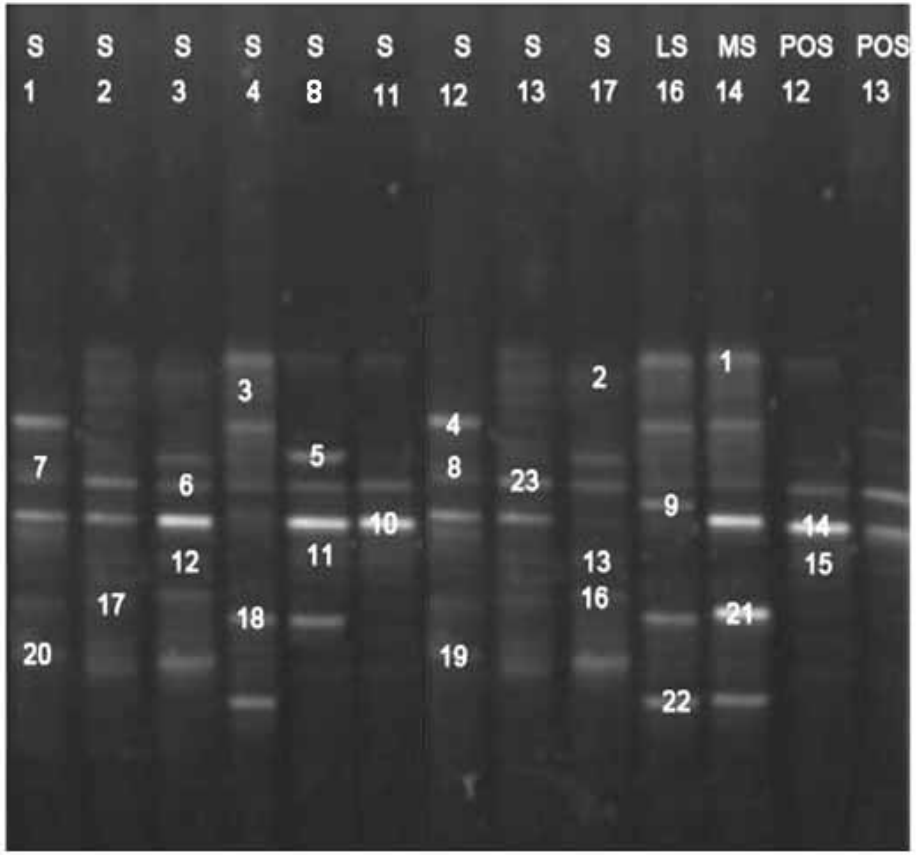
Phylogenetic relationship



Diversity and Structure of Archaea communities in Fildes Peninsula, Antarctica

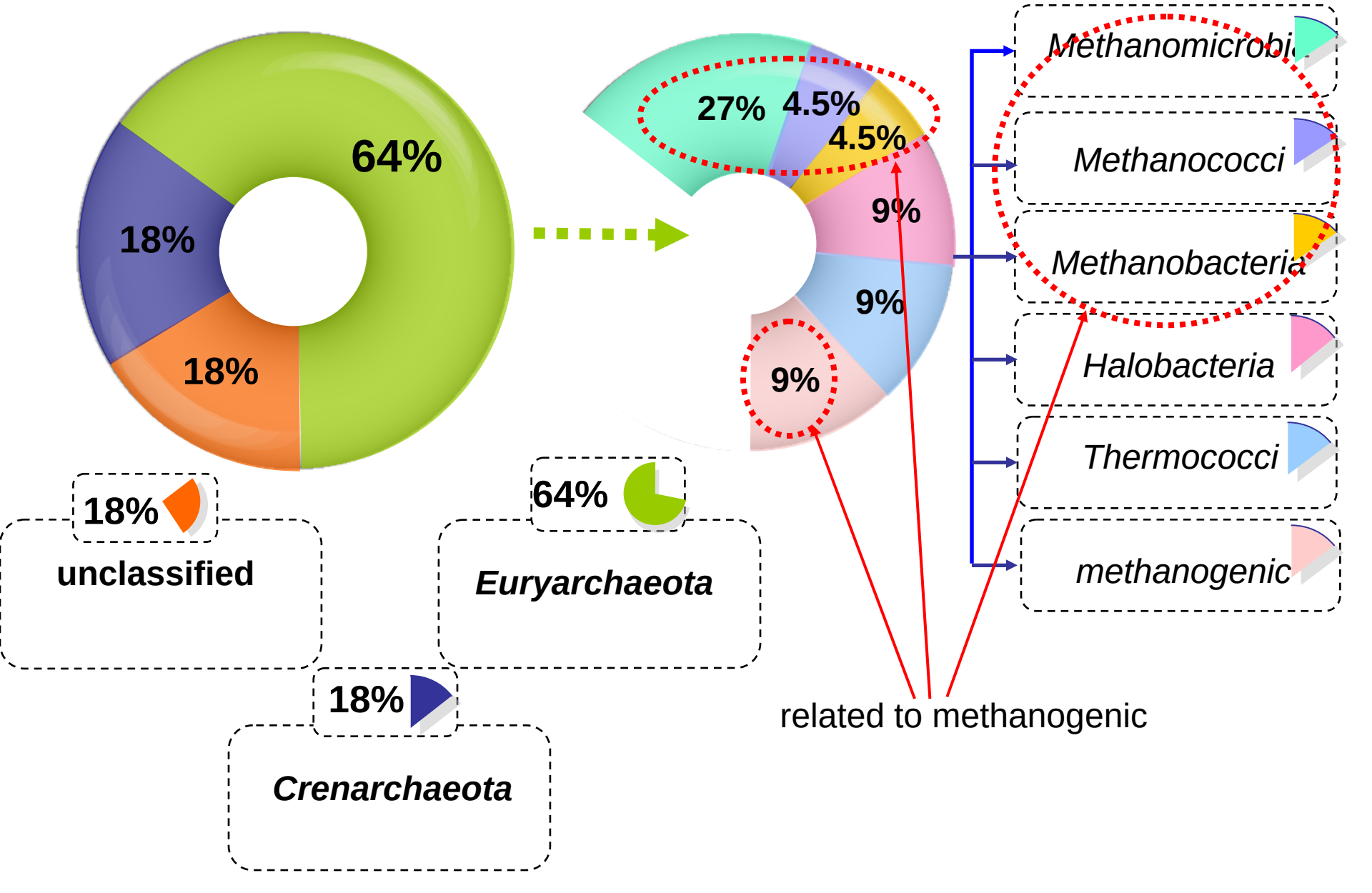
One lineage of microbial life in particular, the Archaea, is especially adapt at exploiting environmental extremes.

Diversity of Archaea by DGGE

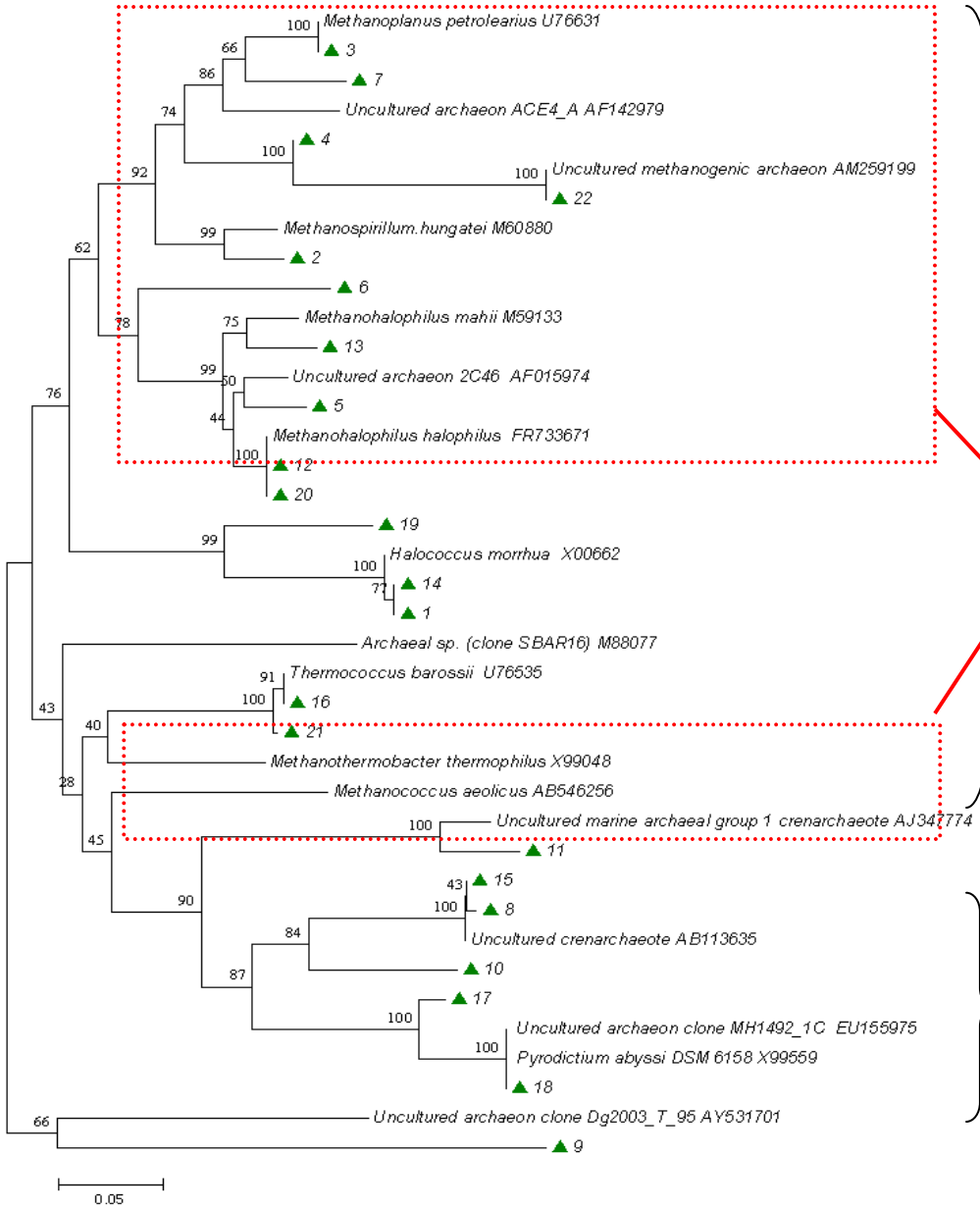


PCR-DGGE profile of the dominant soil Archaea communities in the vicinity of Fildes Peninsula

Composition of the Archaea communities



Phylogenetic relationship



Euryarchaeota

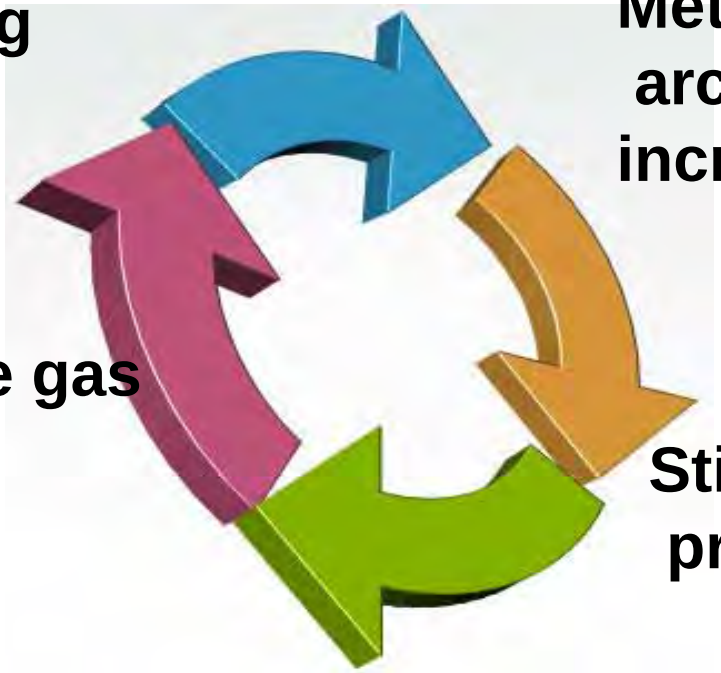
(most were related to *methanogenic*)

Crenarchaeota

Interestingly, most of composition of the Archaea communities were related to methanogenic bacteria

Warming effect

Methanogenic archaea increased



Greenhouse gas emission increased

Stimulation of methane production rates

The relative abundance of the methanogenic archaea also increased with increasing temperature, in line with strong stimulation of methane production rates. Critically, the structure of the community changed with temperature and time, and the relative abundance of some populations was directly affected by temperature.