Flavobacteria in the Southern Ocean

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Abstract

The abundance, spatial distribution and diversity of class Flavobacteria, a bacterial group with a major role in marine secondary production, was investigated in the Southern Ocean euphotic zone of the ice pack off Eastern Antarctica and along a transect at 140-144°E between latitudes 44.7°S to 63.5°S. Samples were comparatively analysed using 16S rRNA gene-based denaturing gradient gel electrophoresis (DGGE), fluorescent in situ hybridisation, real-time PCR and sequence analysis. The results were subsequently compared with direct cultivation approaches.

Surface seawater samples were filter-fractionated into particulate and planktonic fractions and the abundance of particle-associated Flavobacteria, ascertained with real-time PCR and DGGE band analysis using Flavobacteria-specific primers. Flavobacteria abundance was found to be significantly higher in Polar Front Zone (PFZ) and Antarctic Zone (AZ) water samples compared to warmer, nutrient limited Temperate Zone (TZ) and Sub-Antarctic Zone (SAZ) waters. Abundance of particle-associated Flavobacteria positively correlated with seawater chlorophyll a and nutrient concentrations. The abundance of planktonic Flavobacteria populations in the same samples remained relatively static, suggesting increased Flavobacteria abundance may relate to enhanced primary production in the PFZ and AZ. This was supported by comparisons of DGGE profiles that demonstrated significant differences occur in the total Flavobacteria community structure and 16S rRNA gene diversity between samples from the PFZ and AZ with samples from the TZ and SAZ. This suggests a shift to a different, more psychrophilic Flavobacteria community occurs across the Polar Front in the Southern Ocean.
DGGE band sequences revealed a high diversity of class *Flavobacteria* within the Southern Ocean, with 24 genus-level lineages detected. Several of the phylotype clades detected were cosmopolitan in distribution, present in both polar and temperate oceans. Many of the phylotypes clustered in a large, so far uncultivated clade (previously termed “DE cluster 2”) widely distributed in seawater but apparently absent from sea-ice. Cosmopolitan phylotype clades occurred throughout the Southern Ocean, while several additional phylotype groups were found only in the colder waters of the PFZ and AZ.

Examination of the cultivable diversity of *Flavobacteria* in Southern Ocean water samples, using a range of growth media, revealed a number of unique phylotypes including three novel genera, some grouping in clades for which only clones are currently available. Several other strains represented novel species belonging to the family *Flavobacteriaceae*, grouping in the genera *Psychroserpens*, *Polaribacter* and *Tenacibaculum*.

A number of seawater microcosms were utilized to examine the colonization of bacteria-free diatom detritus by planktonic bacterial communities over a period of 30 days at 2°C. *Flavobacteria* phylotypes colonizing diatom detritus, determined by DGGE and real-time PCR analysis, were homologous with the dominant phylotypes in the particle-associated fraction of the samples from which they were taken. Colonisation occurred rapidly (<5 days) and comprised a succession of phylotypes, representing a diversity of *Flavobacteria* lineages. The increasing colonization corresponded to an increase in the dissolution of silicic acid compared with the corresponding control microcosms.
Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for any degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Guy Abell

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# Table of Contents

## CHAPTER 1. INTRODUCTION
1.1. Microbial Ecology of the Southern Ocean 9
   1.1.1. The Southern Ocean marine environment 9
   1.1.2. Biogeochemical cycling and trophism 11
   1.1.3. Microbial functionality 15
   1.1.4. Distribution of microorganisms 17
   1.1.5. Bacterial association with organic particulate matter 21
1.2. The Cytophaga-Flavobacterium-Bacteroides (CFB) phylum in the Southern Ocean 24
   1.2.1. Cultured CFB diversity in the marine ecosystem 24
   1.2.2. Abundance and functionality of the CFB in the Southern Ocean 26
   1.2.3. Culture-independent diversity of CFB in the Southern Ocean 29
1.3. Thesis Project Questions, Goals and Associated Research Design 30

## CHAPTER 2. ABUNDANCE OF FLAVOBACTERIA IN THE SOUTHERN OCEAN
2.1. Summary 33
2.2. Introduction 34
2.3. Methods 36
   2.3.1. Seawater sampling 36
   2.3.2. Fluorescent in situ hybridization (FISH) 37
   2.3.3. DNA extraction and purification 38
   2.3.4. Real-time PCR 39
2.4. Results. 43
   2.4.1. FISH analyses 43
   2.4.2. Real-time PCR analyses. 50
   2.4.3. Nutrient, chlorophyll a an abundance correlations. 50
2.5. Discussion. 54

## CHAPTER 3. BIOGEOGRAPHIC RELATIONSHIPS OF FLAVOBACTERIA IN THE SOUTHERN OCEAN
3.1. Summary 59
3.2. Introduction 60
3.3. Methods 62
   3.3.1. Seawater sampling 62
   3.3.2. DNA extraction and purification 62
   3.3.3. DGGE-PCR 63
   3.3.4 DGGE analysis 63
   3.3.5 Analysis of DGGE banding patterns 65
   3.3.6 Sequencing and phylogenetic analysis 66
3.4. Results. 67
   3.4.1. DGGE banding patterns 67
   2.4.2. DGGE band sequence data 70
3.5. Discussion 77

## CHAPTER 4. BIOGEOGRAPHIC RELATIONSHIPS OF FLAVOBACTERIA IN THE SOUTHERN OCEAN
4.1. Summary 82
4.2. Introduction
4.3. Methods
4.3.1. Isolation and cultivation
4.3.2. Phenotypic characterization.
4.3.3. Whole-cell fatty acid analysis
4.3.4. 16S rRNA gene sequencing and analysis
4.3.5. DNA base composition and DNA:DNA hybridization analysis
4.3.6. Microscopic analysis of Isolates
4.4. Results
4.4.1. Taxonomy of novel CFB phylum isolates
4.4.1.1. Characterisation of strain G812M2 as Gelidimarimicrobium roseum gen. nov., sp. nov.
4.4.1.2. Characterisation of strain G11A1 as Calefactosor marmoris gen. nov. sp. nov.
4.4.1.3. Characterization of strain GAA0204_net2_3 as Maricorpusculum australicum gen. nov. sp. nov.
4.4.1.4. Characterization of strains G512M1 and G512M2 as Psychroserpens cryoceani sp. nov.
4.4.2. Other CFB isolates.
4.4.3. Non-CFB isolates.
4.4.3.1. Gammaproteobacteria isolates
4.4.3.2. Alphaproteobacteria isolates
4.4.3.3. Other isolates
4.5. Discussion
4.6. Descriptions of novel taxa

CHAPTER 5. Colonization and activity of Flavobacteria on diatom detritus.
5.1. Summary
5.2. Introduction
5.3. Methods
5.3.1. Preparation of diatom detritus
5.3.2. Microcosm set-up
5.3.3. Dissolved silica analysis
5.3.4. FISH and 16S rRNA gene-based analyses
5.4. Results
5.4.1. Microcosm silica dissolution
5.4.2. Quantification of Flavobacteria colonizing added diatom detritus
5.4.3. DGGE analysis of Flavobacteria colonizing detritus
5.4.4. Analysis of DGGE band phylotypes
5.4.5. Microscopic examination of detrital particles by FISH
5.5. Discussion

CHAPTER 6.

REFERENCES

APPENDIX
ABBREVIATIONS

AC – Antarctic Convergence
AD – Antarctic Divergence
ACC – Antarctic Circumpolar Current
AZ – Antarctic Zone
PFZ – Polar Front Zone
SAZ – Sub-Antarctic Zone
TZ – Temperate Zone
CDW – Circumpolar Deep Water
AAIW – Antarctic Intermediate Water.
SIMCO – sea ice microbial communities
rRNA – ribosomal ribonucleic acid
CFB – Cytophaga-Flavobacterium-Bacteroides
EPS – exopolysaccharide
FISH – fluorescent in situ hybridisation.
PCR – polymerase chain reaction
DGGE – denaturing gradient gel electrophoresis
DAPI – 4’,6-diamidino-2-phenylindole
PBS – phosphate-buffered saline
EDTA – ethylenediaminetetraacetate
SDS – sodium dodecyl sulfate
G+C – guanosine plus cytosine
nMDS – nonmetric multidimensional scaling
ANOSIM – analysis of similarity
FAME – fatty acid methyl esters
GC-MS – gas chromatography-mass spectrometry
$T_{OR}$ – optimal temperature for renaturation
(F)ASW – (filtered) artificial seawater
Publications related to this thesis as of March 2005:


#Covers research detailed in Chapters 4 and 5.
* Covers research detailed in Chapters 2 and 3.