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Alder-*Frankia* Symbionts Enhance the Remediation and Revegetation of Oil Sands Tailings

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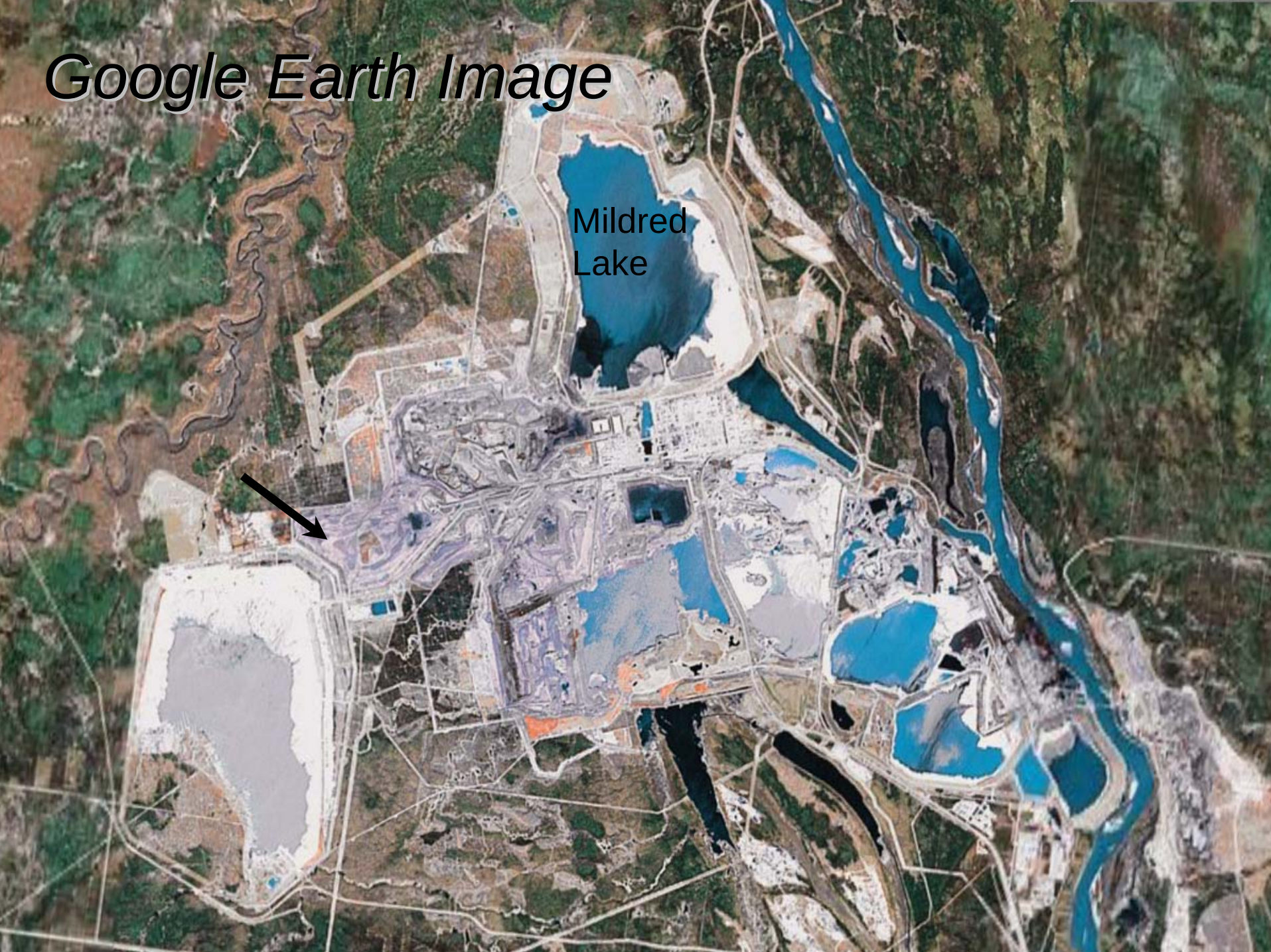
Google Earth Image
Mildred
Lake

Oil Sands Operations, Fort McMurray

Tailings sands and tailings water

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Objectives

- Develop efficient greenhouse production procedures for alder-*Frankia* symbionts
- Develop a protocol for studying rhizosphere microflora inside and outside the root system
- Screen alders and symbionts in greenhouse trials for use on tailings sands (TS) and composite tailings (CT)
- Evaluate the performance of symbiont alders in a field trial on tailings sands
- Determine the impact of rhizosphere microflora on the degradation of hydrocarbon contaminants


F9-inoculated, 6.5 months

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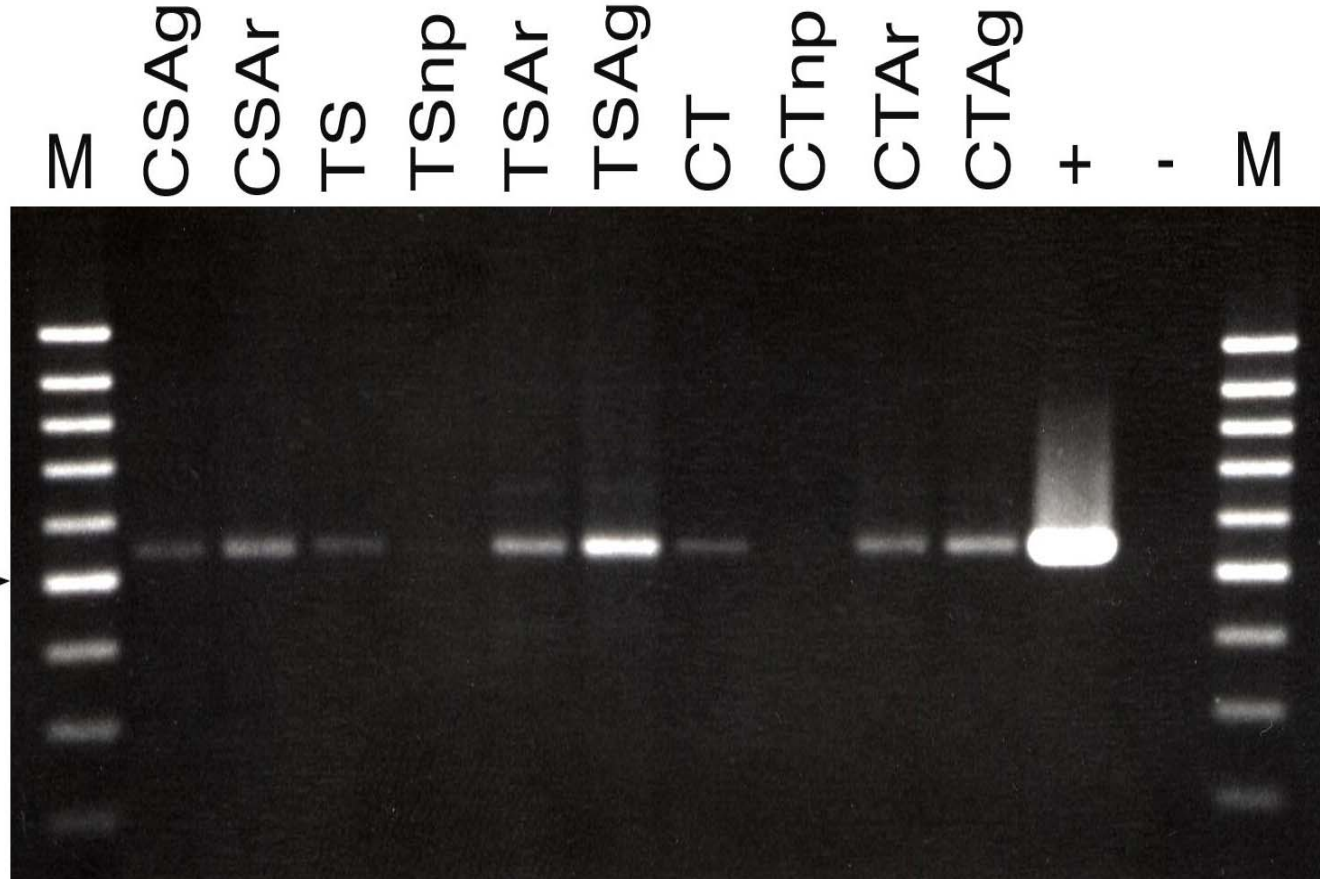
Alder roots penetrating CT sand

alkB PCR



CT: Composite Tailings
TS: Tailings
AR: *A. rugosa*
AG: *A. glutinosa*

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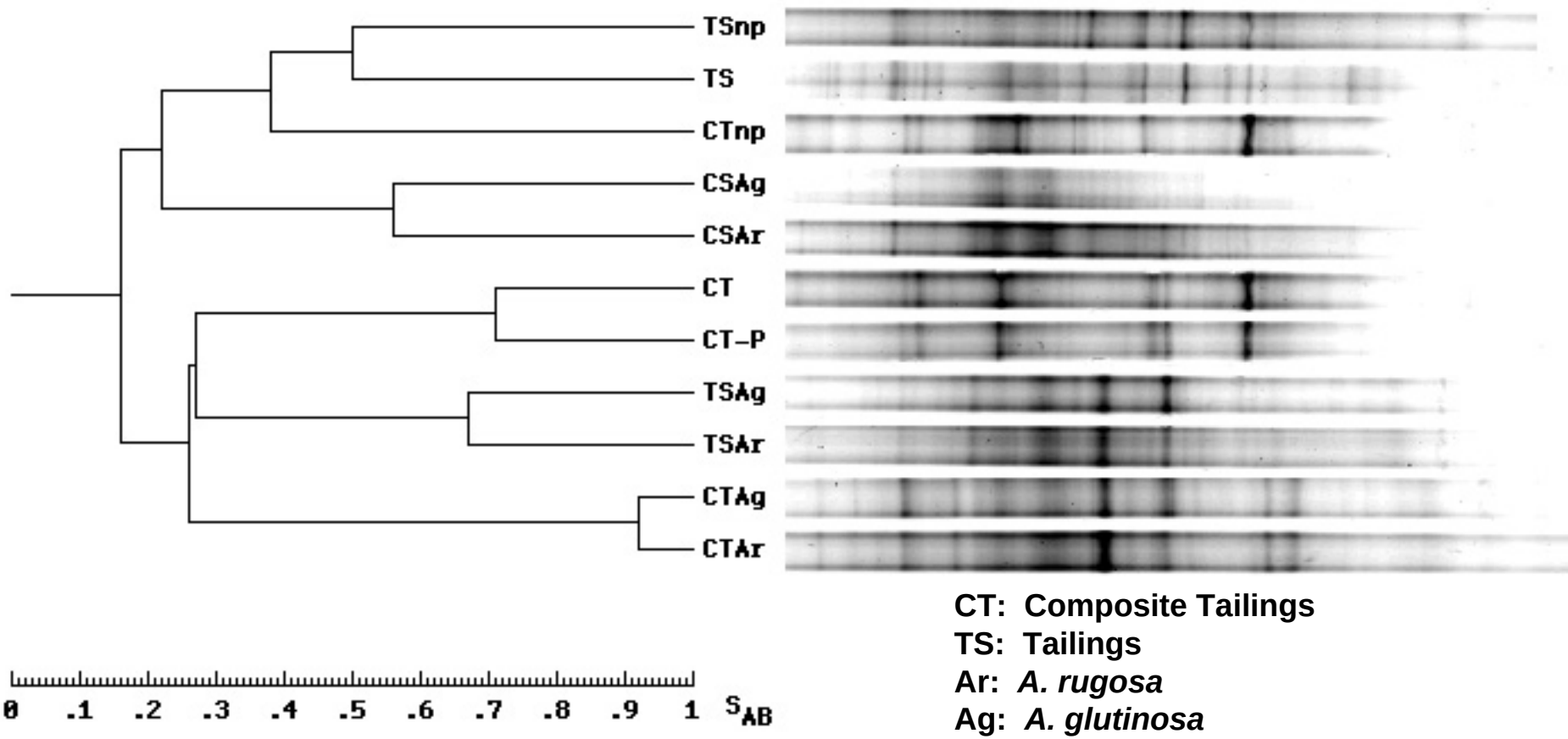
Denaturing Gradient Gel Electrophoresis (DGGE)

- demonstrates relatedness of different microbial communities



CT: Composite Tailings
TS: Tailings
Ar: *A. rugosa*
Ag: *A. glutinosa*
np: not planted

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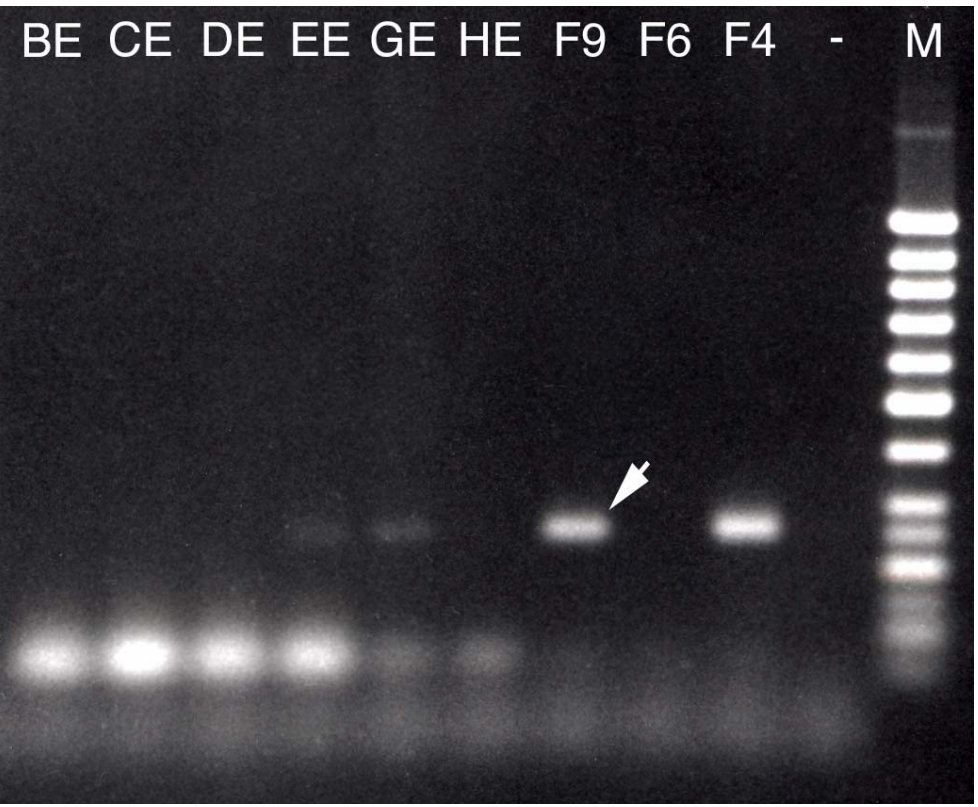
Detection of F9 in endophytic community



- primers designed from IGS between *nifD-nifK*
- inoculated strain can be detected in alder endophytic microbial community
- can determine if 'right' microorganisms present
- can also determine if undesirable microorganisms are present


High saline-alkaline site
composed of mainly overburden
2005 6 10


Initial Planting
2005 6 19

Alders growing in the field (1.5 yrs)

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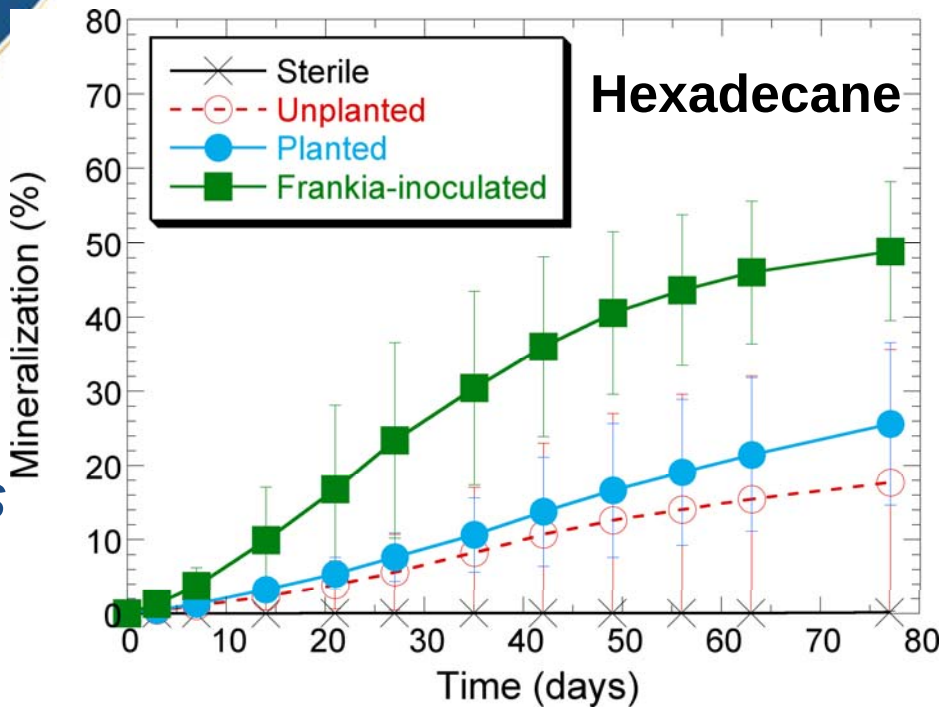
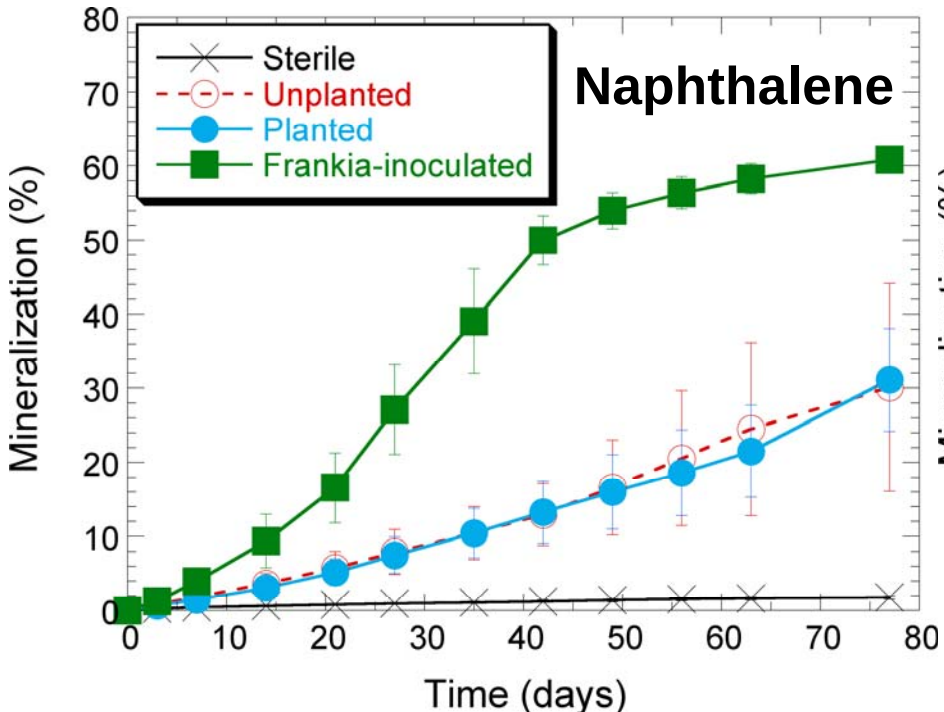
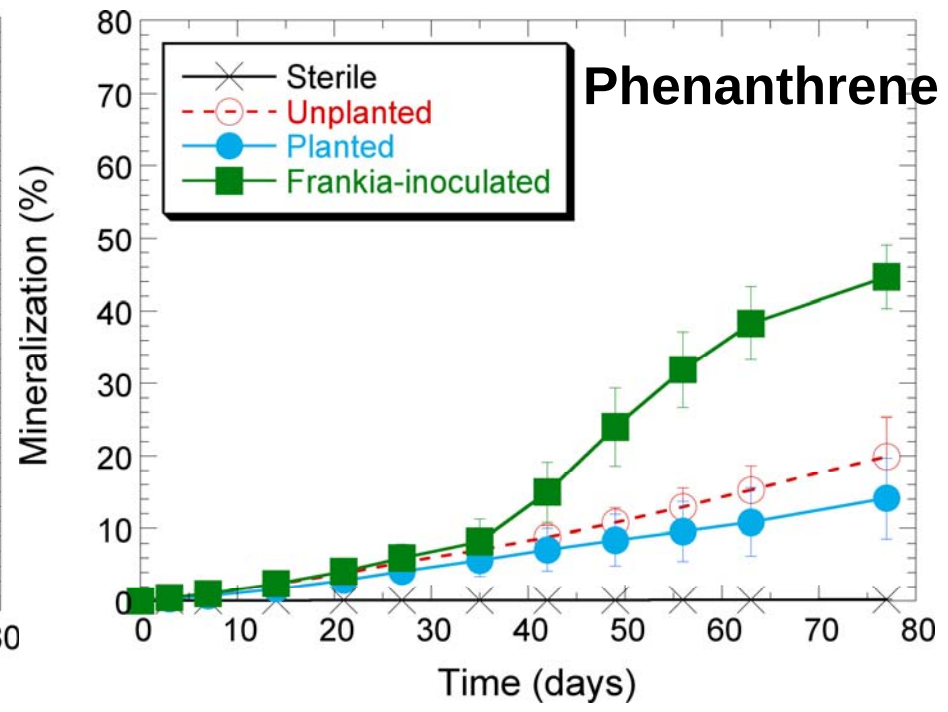
Hydrocarbon mineralization in bulk field soil planted with alders







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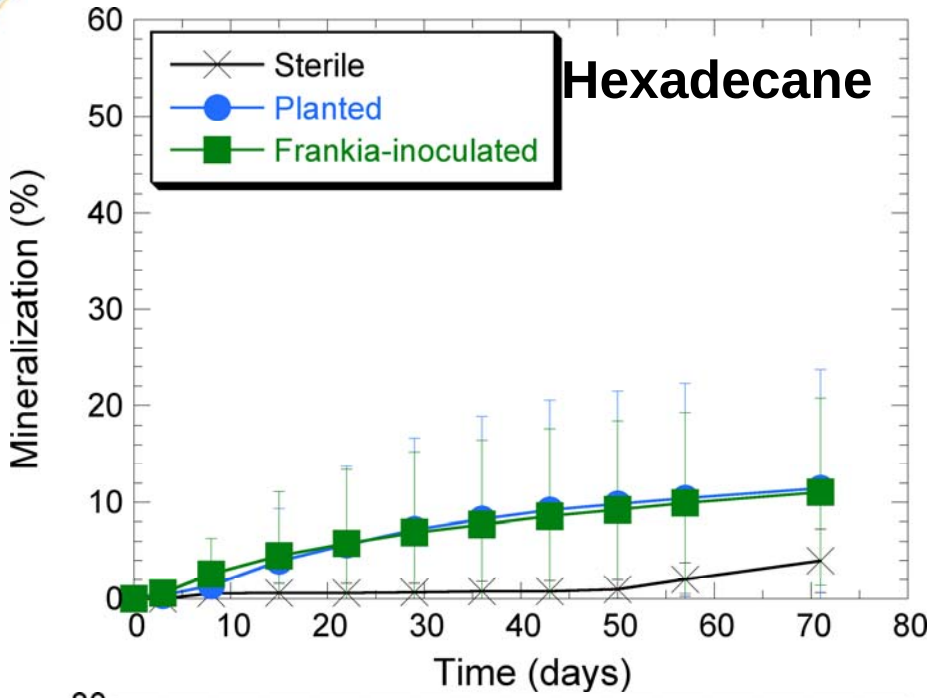
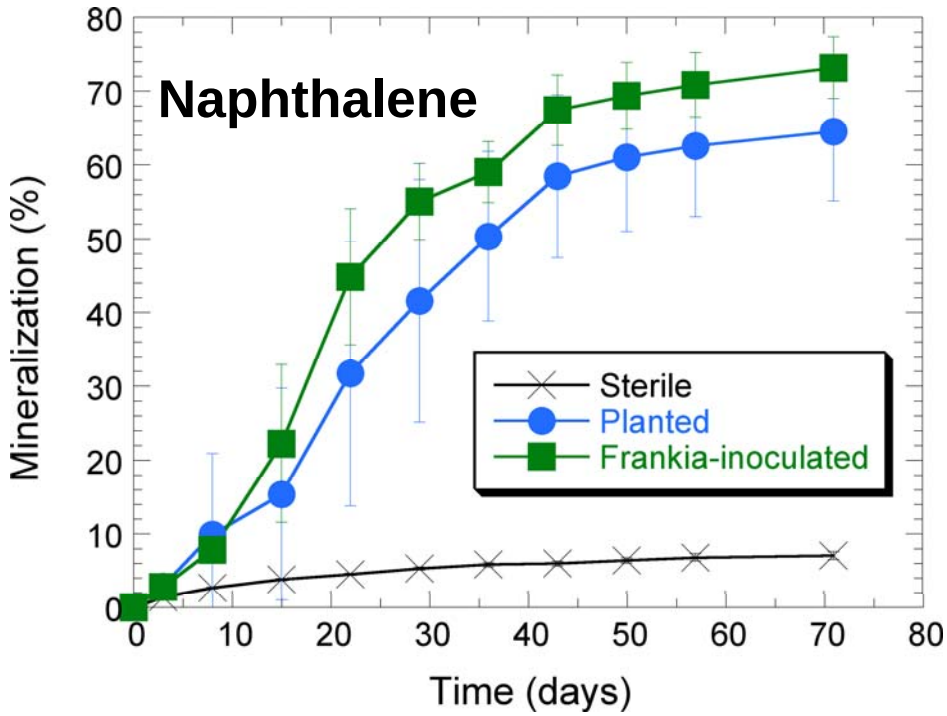
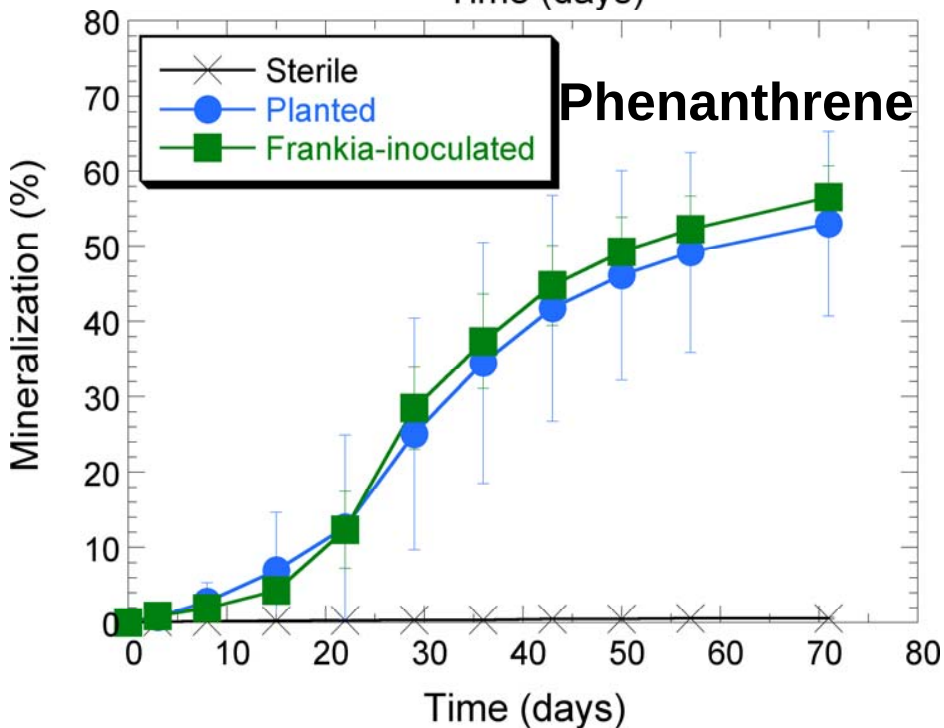
Hydrocarbon mineralization in the rhizosphere of alder planted soil







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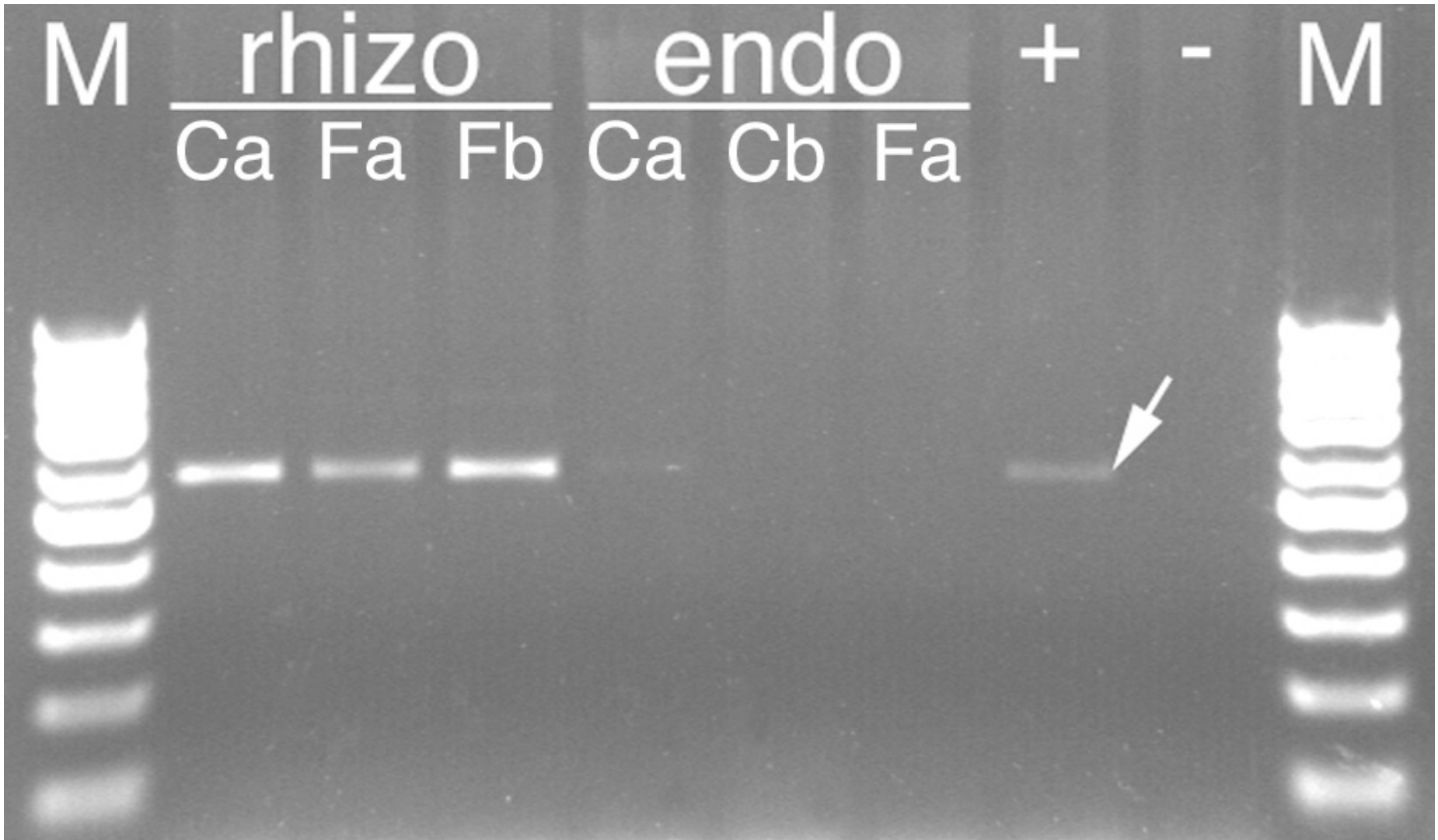
PCR analysis of alkB in field plants



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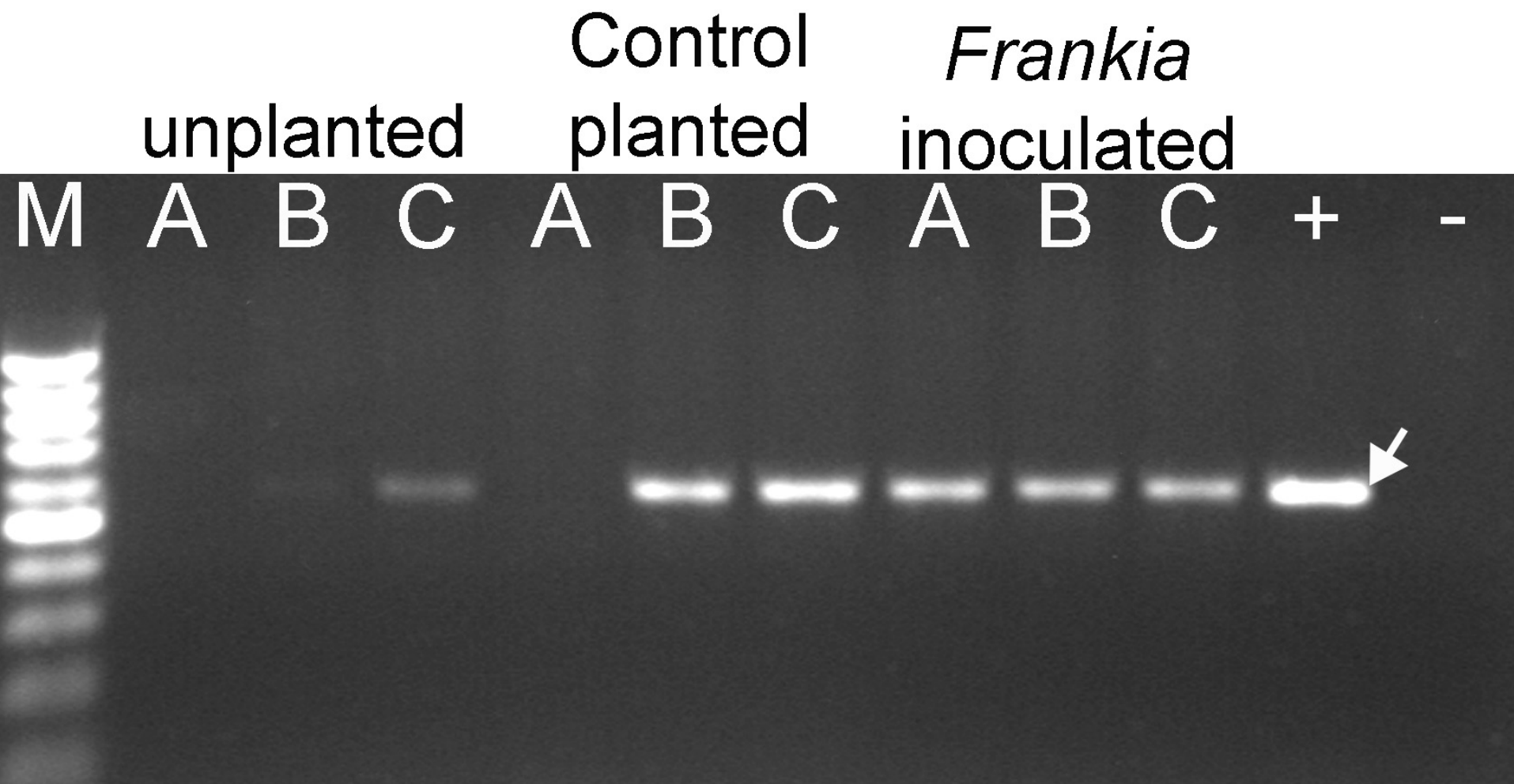
alkB Analysis of Bulk Soil From Plots of Unplanted, Control Alder Planted and Frankia-inoculated Alder



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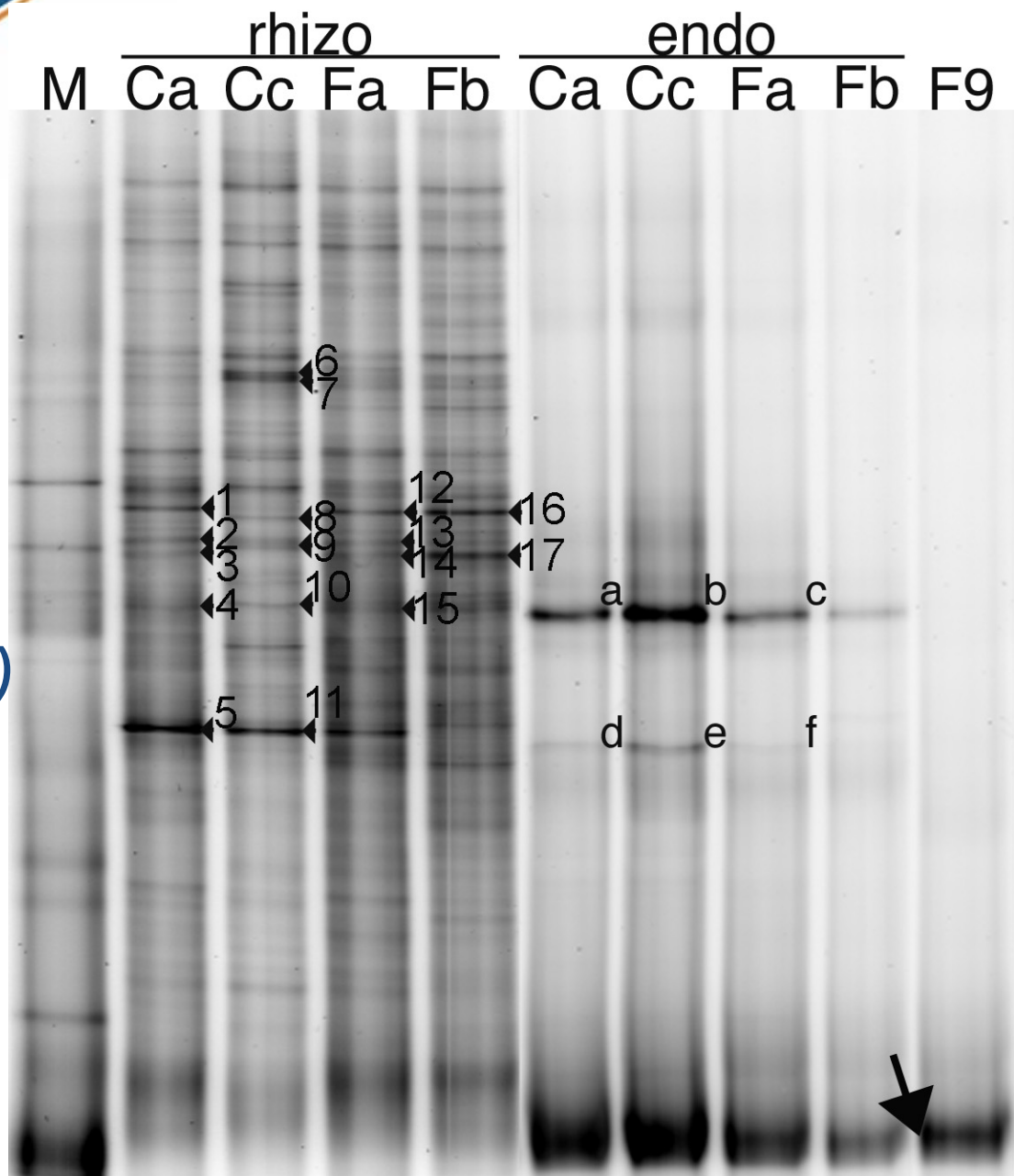
DGGE Analysis of Rhizospheric and Endophytic Microbial Communities From Frankia-inoculated (F) and Non-Inoculated (C) Alders



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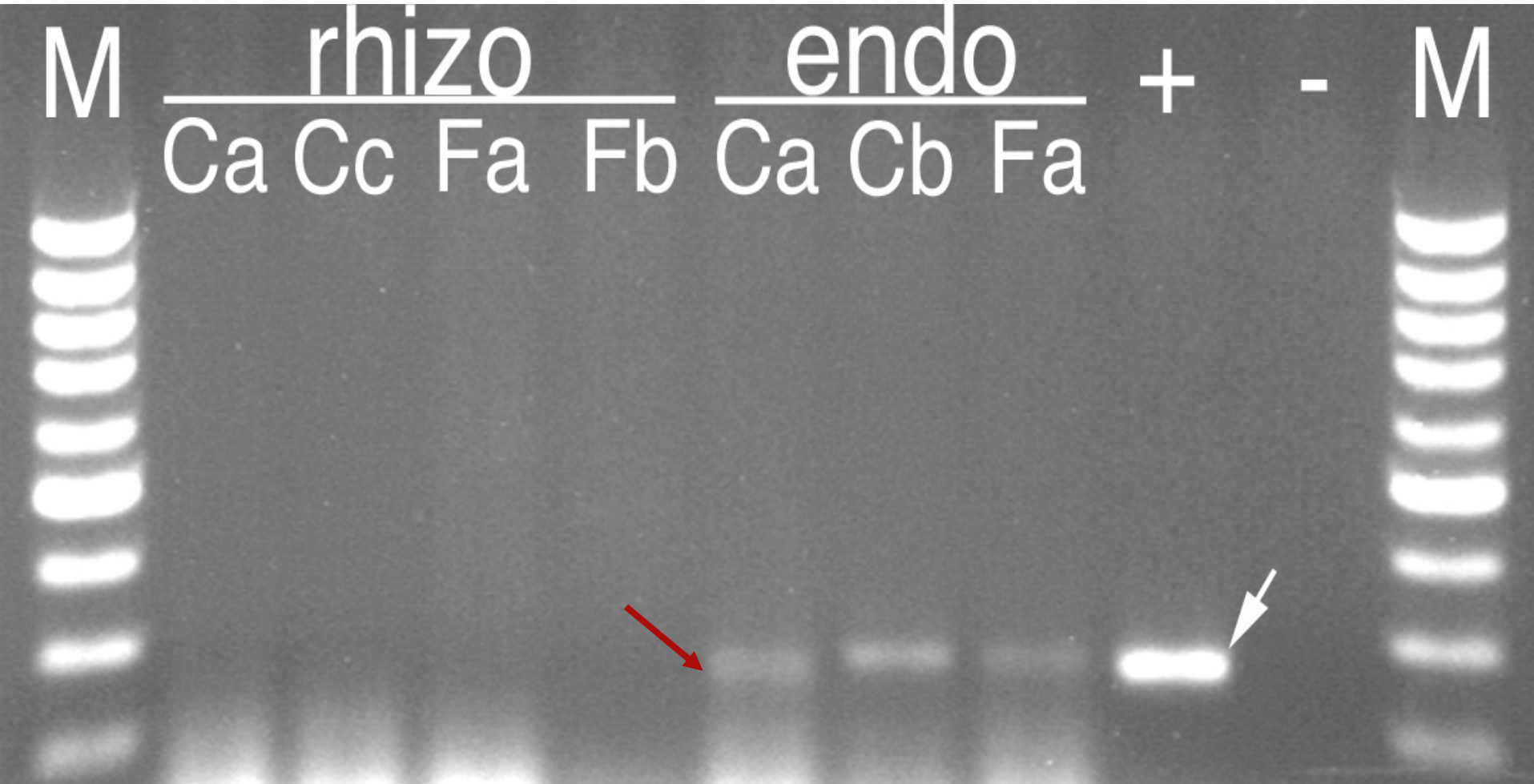
Detection of Frankia in endophytic community



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Soil Quality

- pH ↘
- OM ↗
- Electrical conductivity ↘
- CEC ↗
- Bulk Density ↘
- Nutrients and salt content

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Field Results: Soil Quality Parameters

	pH	buffer-pH	K (kg/ha)	Mg (kg/ha)	Na (kg/ha)
Unplanted	7.5	7.5	211	1533	498
Planted Control	7.5	7.5	217	1697	359
Planted Frankia	6.6 ↓	7.0 ↓	116 ↓	1637	160 ↓

	Saturation (%)				
	K	Mg	Ca	K+Mg+Ca	Estimated CEC
Unplanted	1.1	25.1	73.8	100.0	23.0
Planted Control	1.0	25.9	73.1	100.0 ↓	24.5 ↑
Planted Frankia	0.5	22.4	62.4	85.3	27.2

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Summary

- in greenhouse trials, *Frankia*-inoculated alders grew better in tailings sands (biomass, root development), and had a positive impact on indigenous soil microorganisms (higher population densities, greater hydrocarbon degradation activity)
- field trials on tailings sands were initiated in 2005 using *Frankia*-inoculated (actinorhizal) and *Hebeloma*-inoculated (ectomycorhizal) green alders (*A. crispa*).
- *Frankia*-inoculated alders showed comparable results to greenhouse trials (increase in microbial degradation activity, plant biomass) after more than 2.5 years in the field.
- field trials showed improved soil quality characteristics after only one year, demonstrating the promise of the technology.
- analysis of field plants after 2.5 years currently in progress.

Frankia-inoculated, after 2.5 years


Control plant


Frankia-inoculated alder (A. crispa)

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Acknowledgements

- Alberta Ingenuity Fund
- Syncrude Canada Ltd.
- Bonnyville Forest Nursery
- Université Laval, Quebec
- Université de Sherbrooke, Quebec
- PERD-NRCan

Nathalie Fortin
Suzanne Labelle
Nicolas Girardin
Nathalie Guibord

ALBERTA INGENUITY FUND

Syncrude

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