Microbial Populations in Acid Sulfate Soils: Potential Role in Metal and Acid Release

Xiaofen Wu, Zhen Lim Wong, Pekka Sten, Sten Engblom, Peter Österholm & Mark Dopson

Lecture

- Metal dissolution & acid generation
- Microorganisms in acid environments
- Microorganisms in PASS & ASS
- Conclusions

Microbial Facilitated Pyrite Dissolution

Chemical oxidation:

$$FeS_2 + {}^{7}/_{2}O_2 + H_2O \longrightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$$

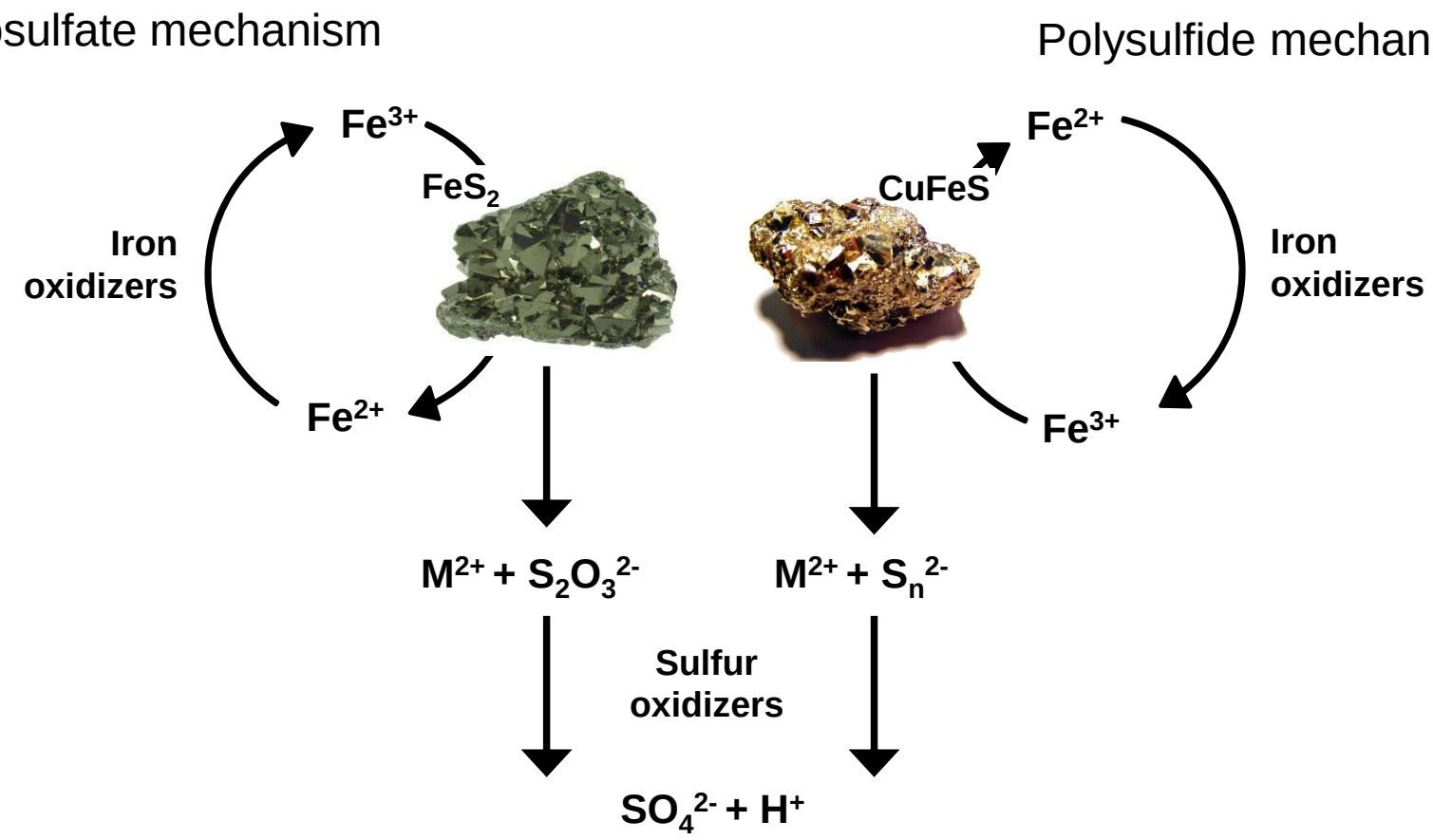
Oxidation by Ferric Iron:

$$FeS_2 + 14Fe^{3+} + 8H_2O \longrightarrow 15Fe^{2+} + 2SO_4^{2-} + 16H^+$$

Fe^{3+} provided by microbes:

$$14Fe^{2+} + {}^{7}/_{2}O_2 + 14H^+ \longrightarrow 14Fe^{3+} + 7H_2O$$

Metal Dissolution & Acid Generation



Modified from Schippers & Sand (1999) Appl Environ Microbiol 65: 319-321

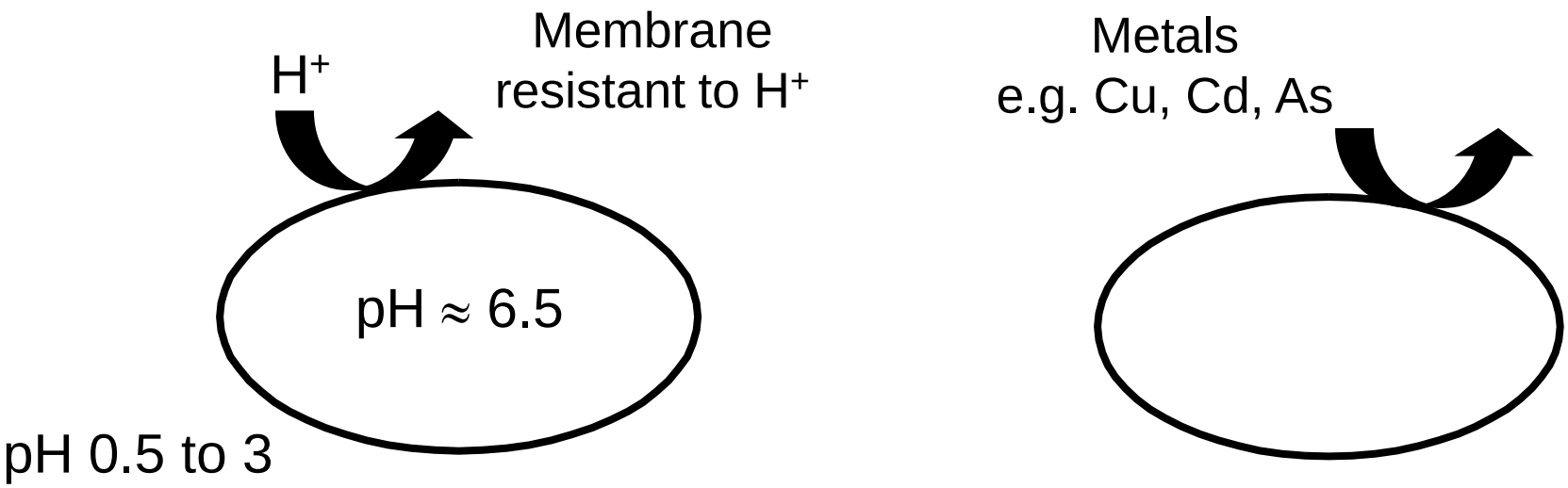
Lecture

- Metal dissolution & acid generation
- Microorganisms in acid environments
- Microorganisms in PASS & ASS
- Conclusions

Microorganisms in Acid Environments

- Found in all domains of life
- Heterotrophs (utilize organic carbon) & autotrophs (use CO_2 from the air)
- Iron & sulfur compound oxidizers
- Adapted to low pH and high metal concentrations

Microorganisms in Acid Environments



Acidophiles often highly metal resistant

Lecture

- Metal dissolution & acid generation
- Microorganisms in acid environments
- Microorganisms in PASS & ASS
- Conclusions

Microorganisms in PASS & ASS

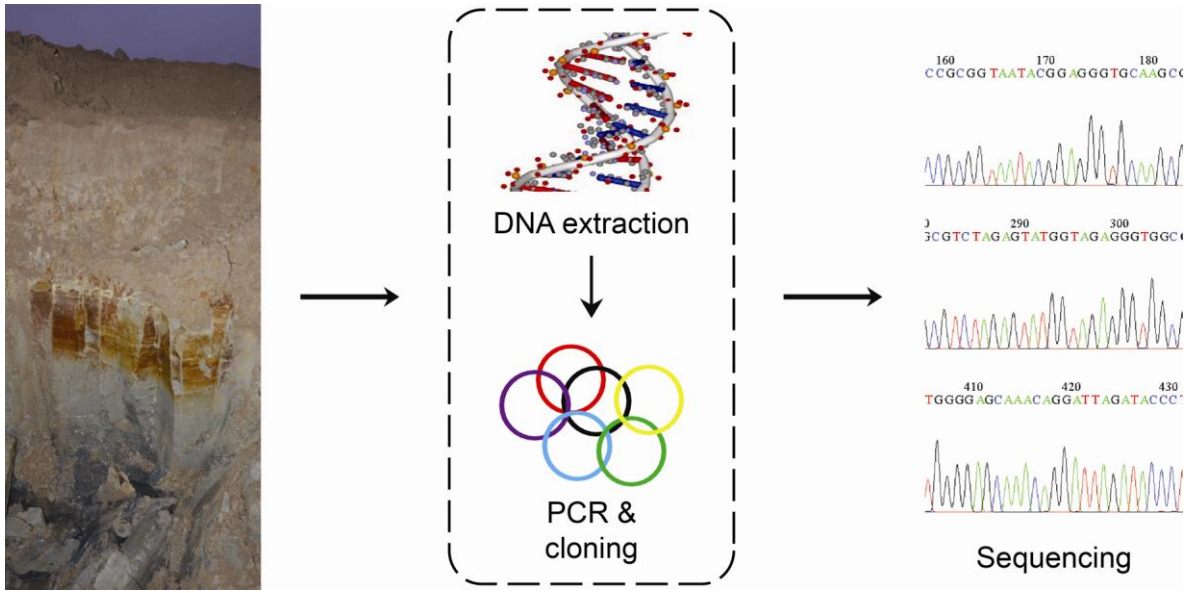
Plough layer; pH >4.7
(30cm below the surface)

Red oxidized; pH 3.7 – 4.2 (75 cm)

Mixed partially oxidized; pH 4 to 6 (127 cm)

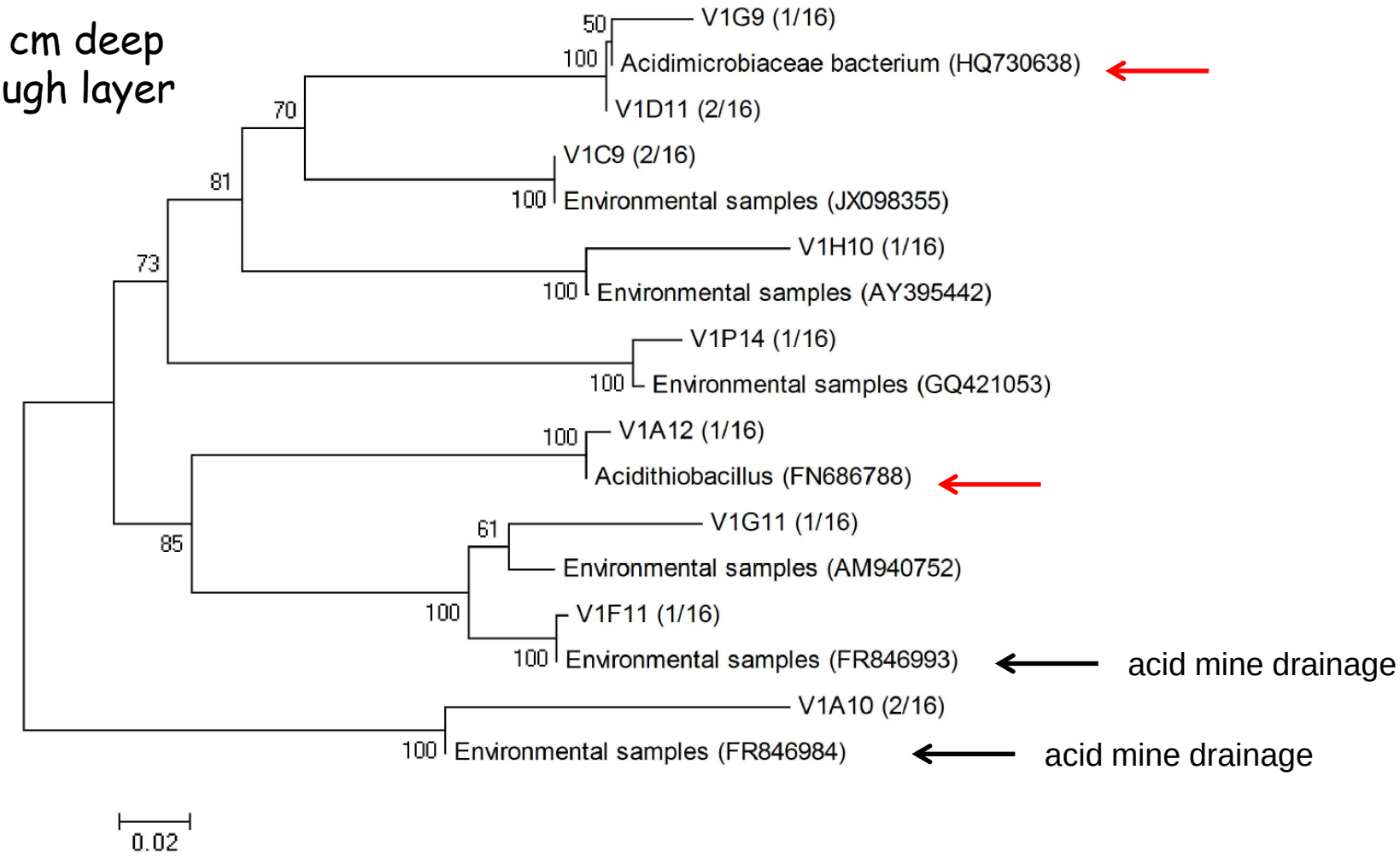
Dark reduced zones; pH ~ 7 (>180 cm)

Microbial Identification

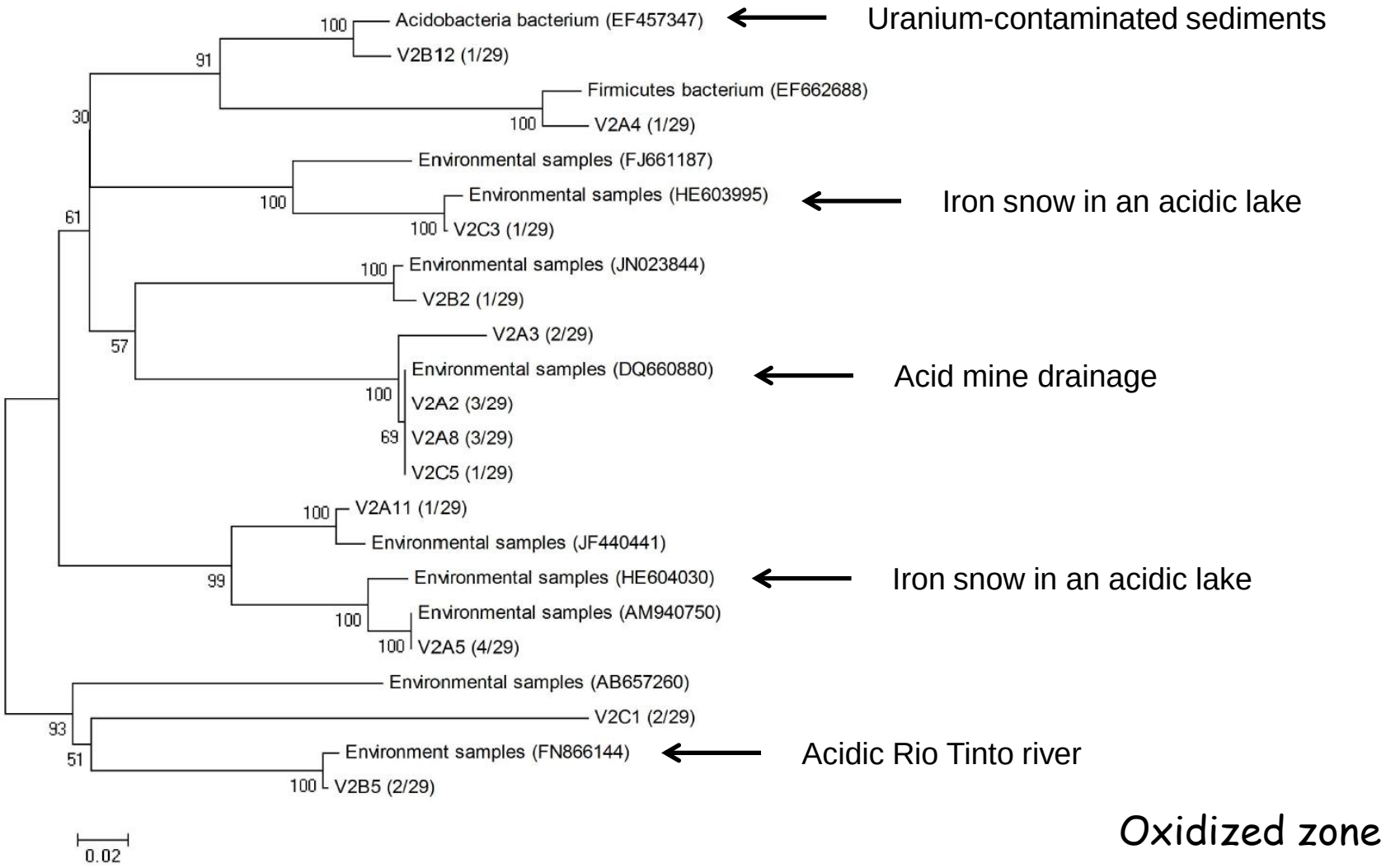


Microorganisms in PASS & ASS

30 cm deep plough layer

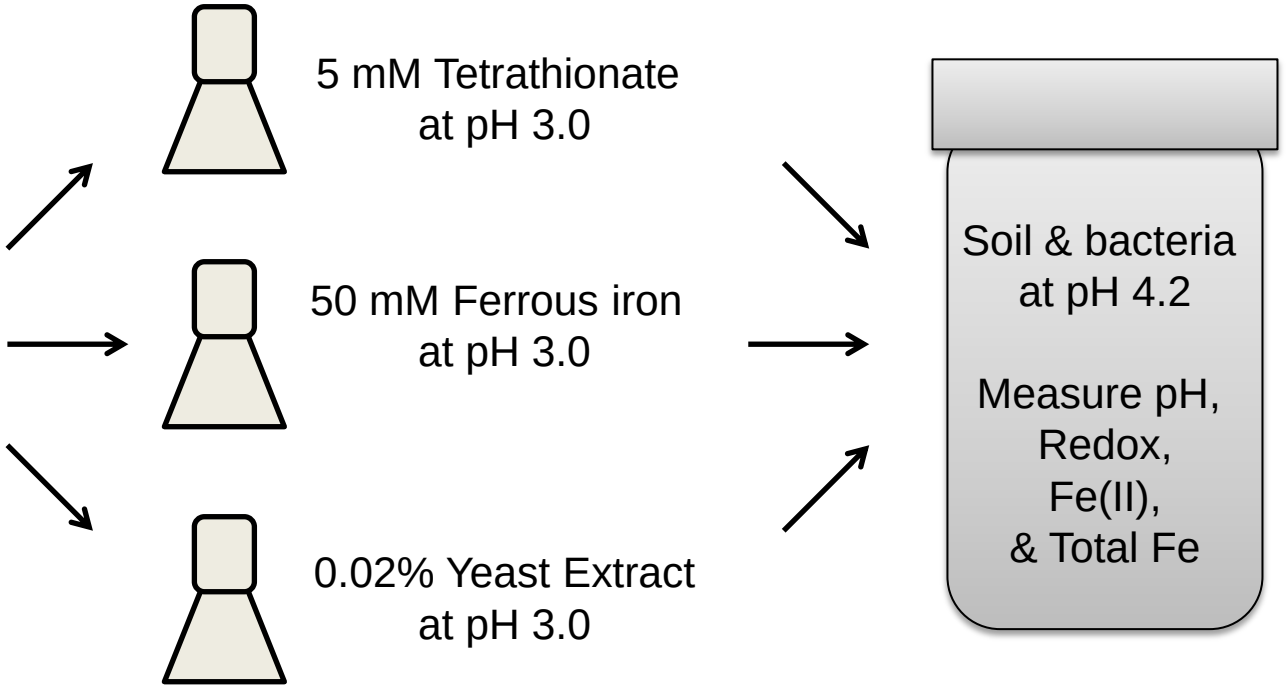


Microorganisms in PASS & ASS



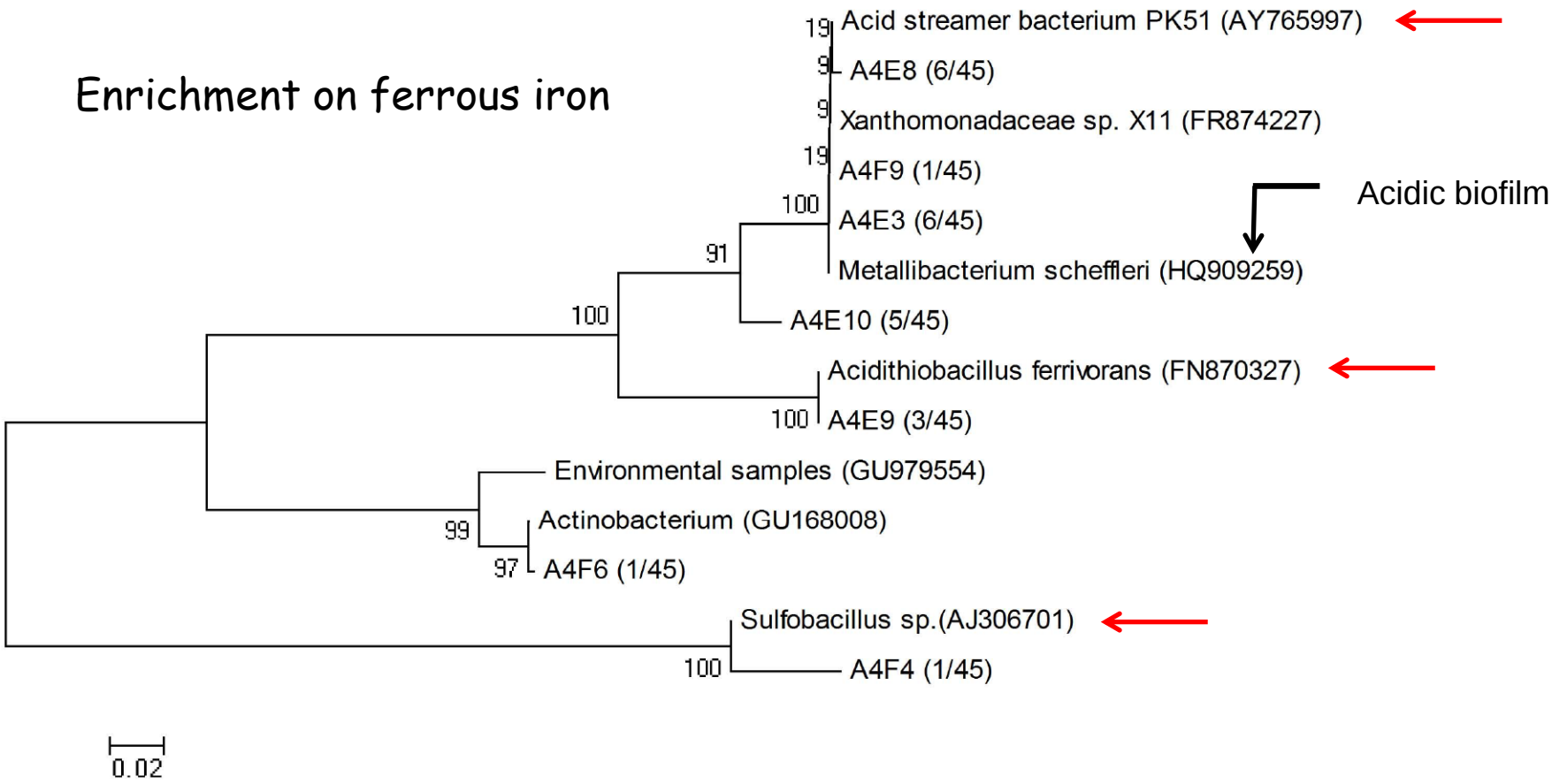
Oxidized zone

Metal & Acid Release

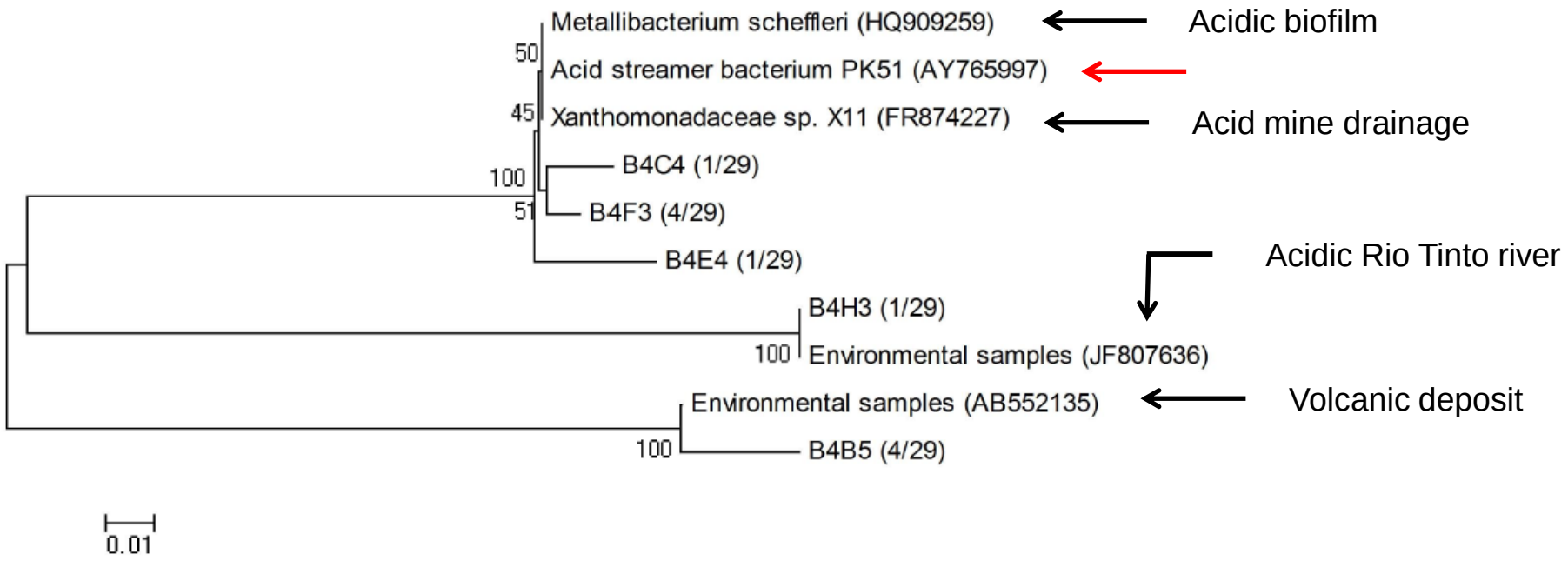


Enriched Microorganisms

Enrichment on ferrous iron

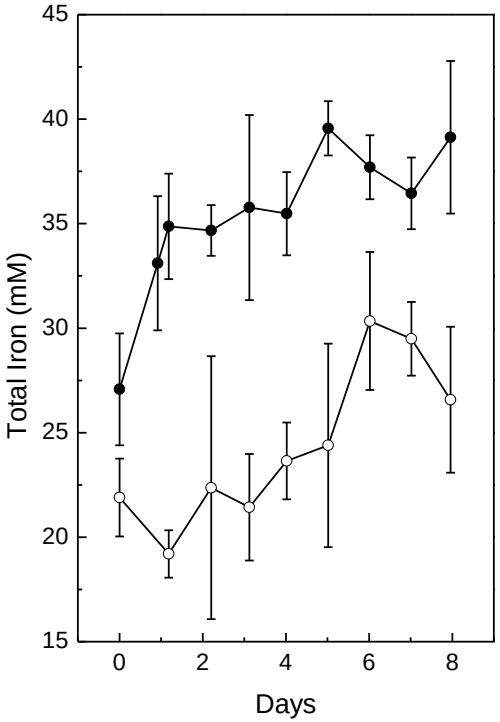


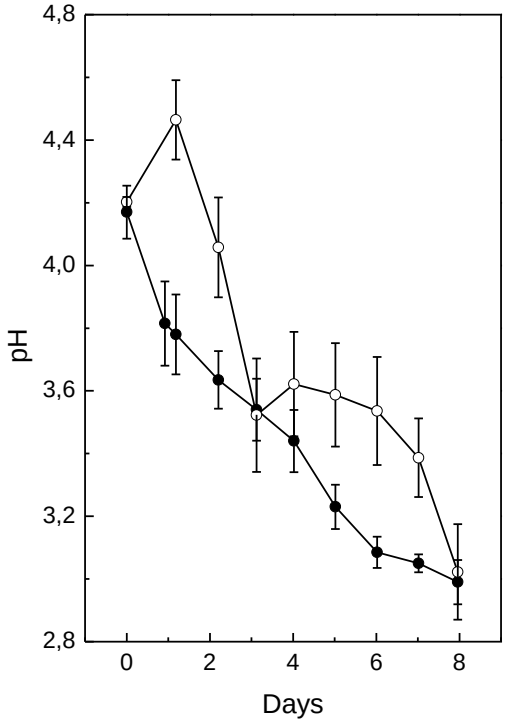
Enriched Microorganisms

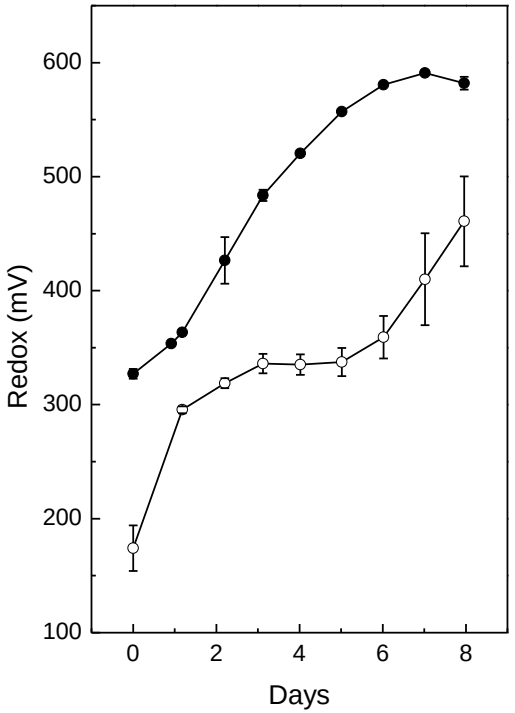


Enrichment on tetrathionate

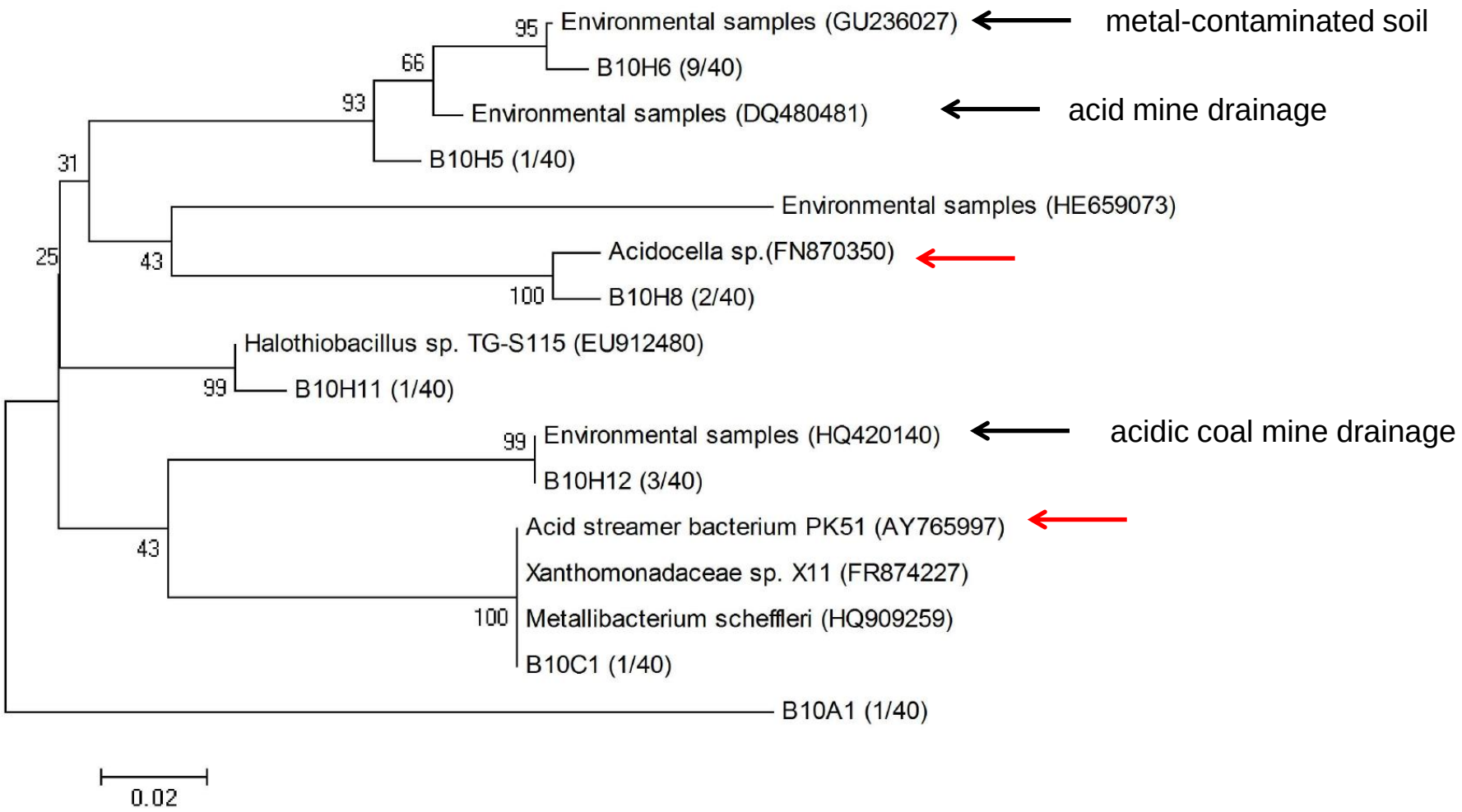
Metal & Acid Release







Microorganisms After Bioleaching



Lecture

- Metal dissolution & acid generation
- Microorganisms in acid environments
- Microorganisms in PASS & ASS
- Conclusions

Conclusions

- Acidophilic microorganisms are found in ASS
- Both ferrous iron and sulfur oxidizers identified
- Initial experiments suggest acidophiles influence metal release from PASS

Acknowledgements

Financial support: K.H. Renlunds Stiftelse

Linnaeus University, Sweden
Students: Xiaofen Wu & Zhen Lim Wong

Vaasa University of Applied Sciences, Finland
Pekka Sten

Novia University of Applied Sciences, Finland
Sten Engblom

Åbo Academy University, Finland
Peter Österholm