Antibiotic resistance genes and residues in water and soils in close proximity to swine production facilities (molecular ecology section)

A.C. Yannarell[1]
R.I. Mackie[1], I.G. Krapac[2], J.C. Chee-Sanford[1,3], Y.-F. Lin[4], S. Koike[1]

[1]University of Illinois at Urbana-Champaign
[2]Illinois State Geological Survey
[3]US Department of Agriculture
[4]Illinois State Water Survey

Acknowledgements

Co-Investigators

RI Mackie
JC Chee-Sanford
IG Krapac
Y-F Lin

Collaborators

EG Zoetendal
RI Aminov
A Jindal
L Raskin
JL Zilles
N Garrigues-Jeanjean

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Students and post-docs

HD Oliver-Gans
M Ekizoglu
S Koike
S Kocherginskaya
S Maxwell

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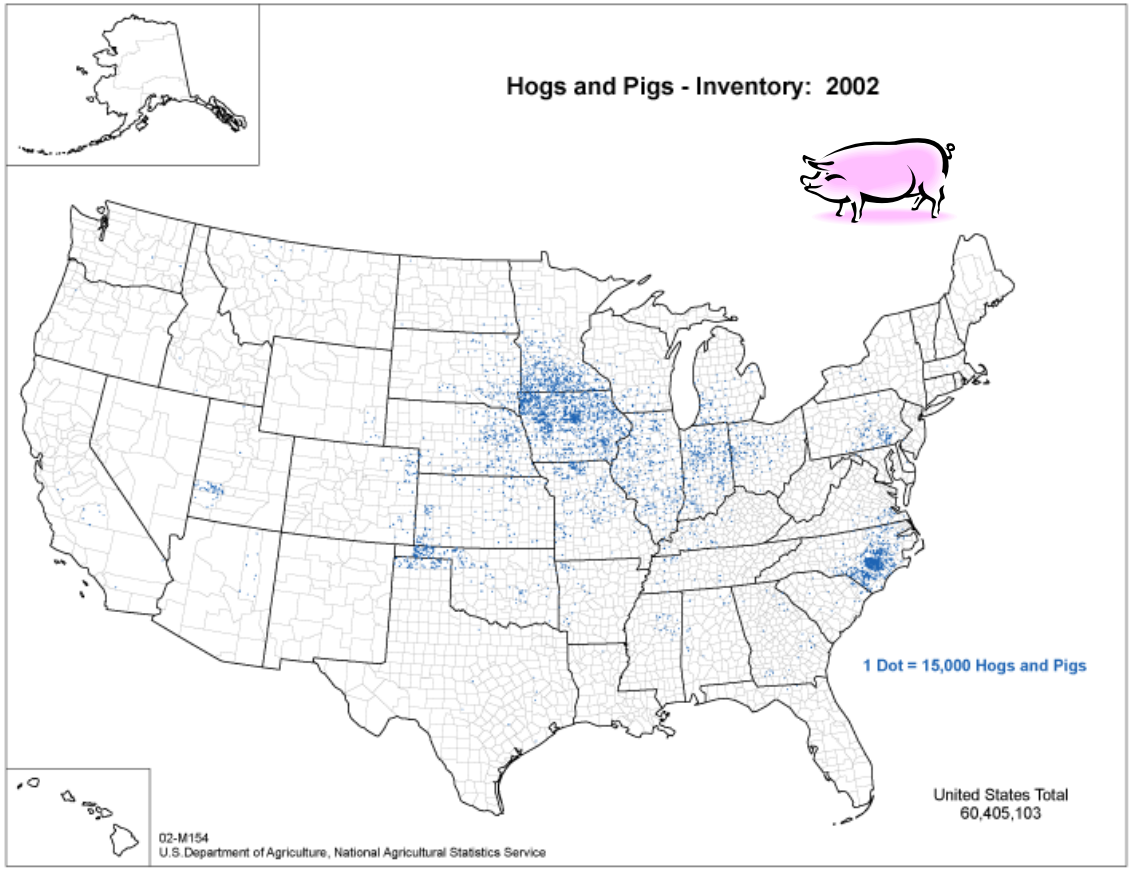
US pig population (2002)



Top hog states

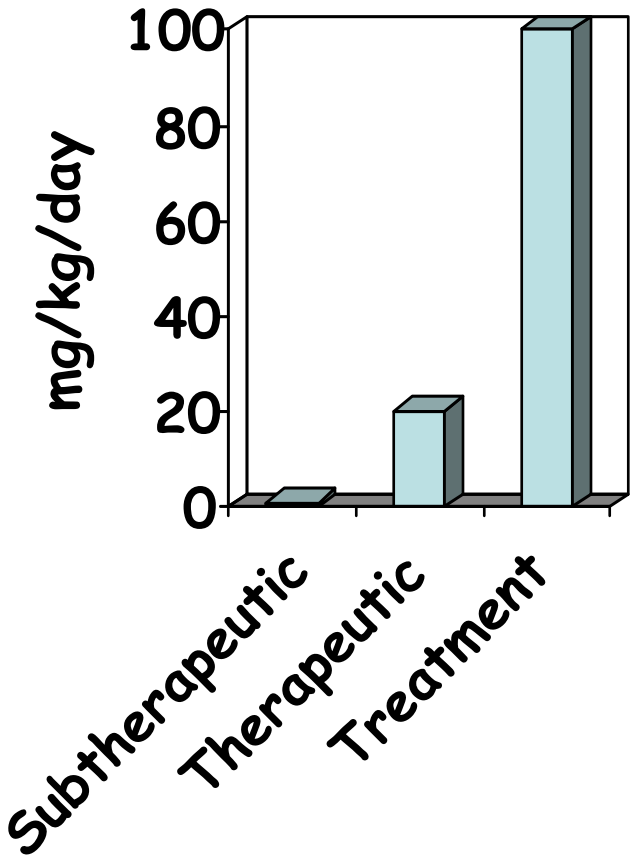
- Iowa
- North Carolina
- Minnesota
- Illinois
- Missouri

In 2000 >50% of swine facilities were within 1 mile of another facility

Antibiotics in animal production

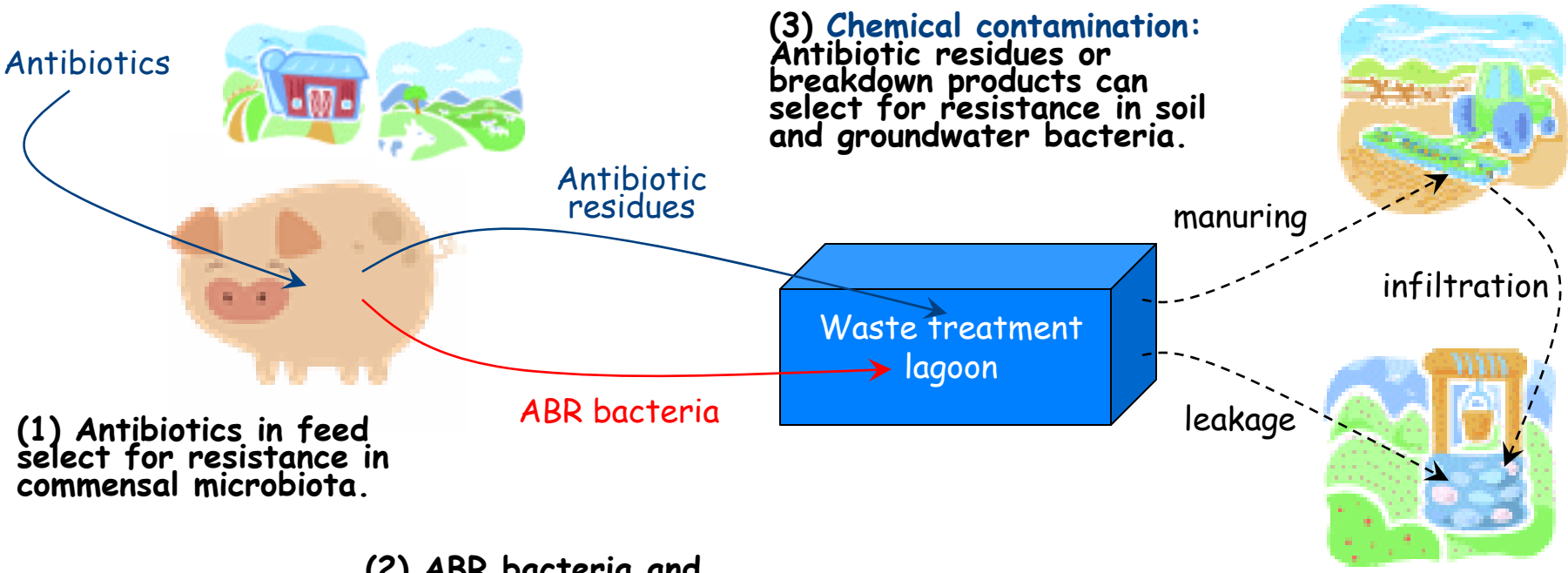
Three general uses:

1) Subtherapueutic
   - *Growth promotion*
   - *Feed efficiency*
2) Therapeutic (prophylaxis)
   - *Disease prevention*
3) Disease treatment



Antibiotics in animal production

The nature of antibiotic contamination



(1) Antibiotics in feed select for resistance in commensal microbiota.

(2) ABR bacteria and unabsorbed antibiotics enter the waste treatment system.

(3) **Chemical contamination:** Antibiotic residues or breakdown products can select for resistance in soil and groundwater bacteria.

(4) **Microbiological contamination:** ABR bacteria may persist in soil or groundwater. Alternately, they can pass their ABR genes to native soil and groundwater bacteria via horizontal gene transfer.

Results of previous research

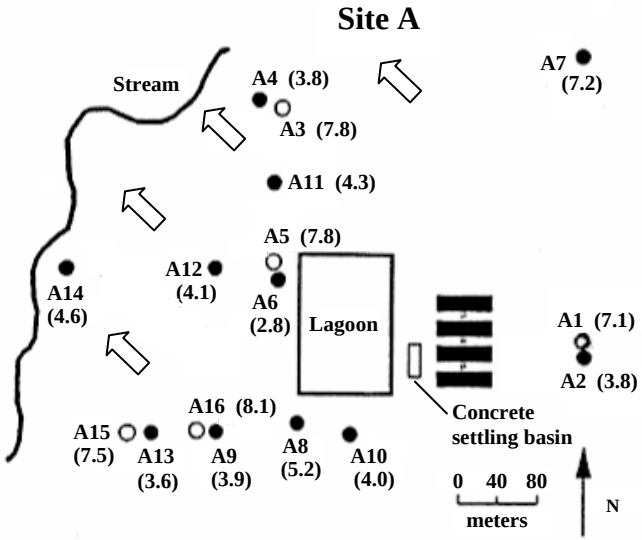
Genetic determinants of tetracycline-resistance (tet) were found in components of swine feed -- including an organic farm

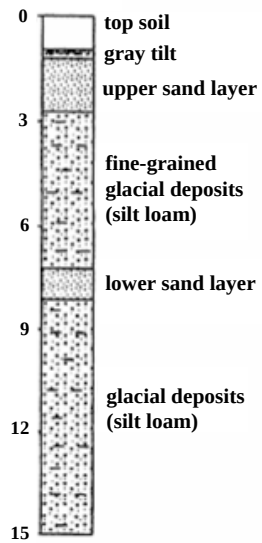
A diversity of tet genes were found in swine feces, confinement buildings, manure treatment systems, and groundwater wells

Control wells also contained tet genes

Aminov et al. 2001. AEM 67: 22-33
Chee-Sanford et al. 2001. AEM 67: 1494-1502
Aminov et al. 2002. AEM 68: 1786-1793

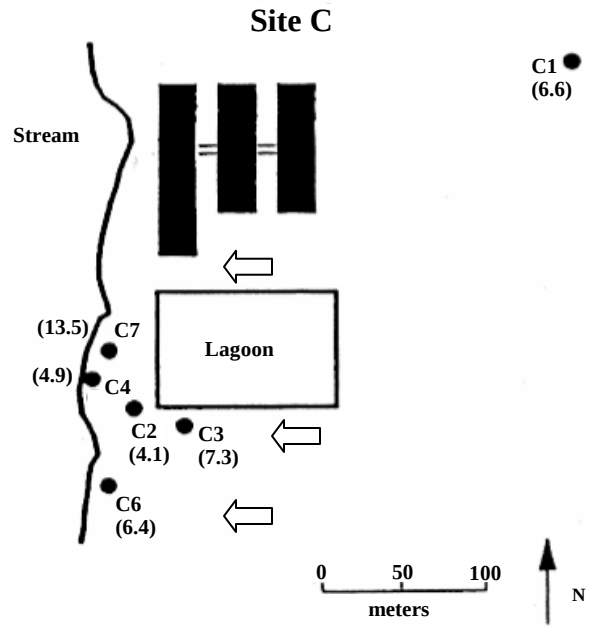
Facilities overview

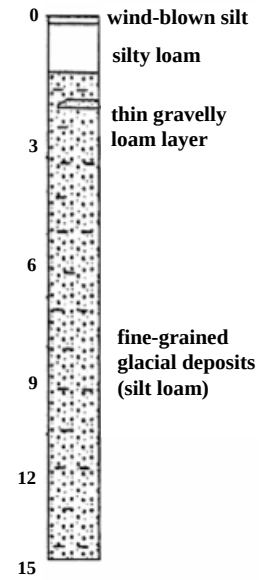




Site A:
bacitracin, tylosin, chlorotetracycline

Site C:
penicillin, tyolsin, chlorotetracycline





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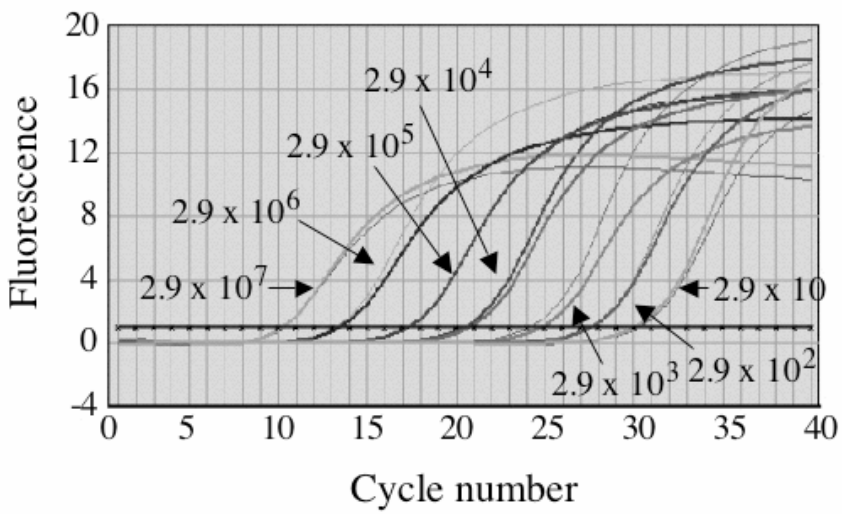
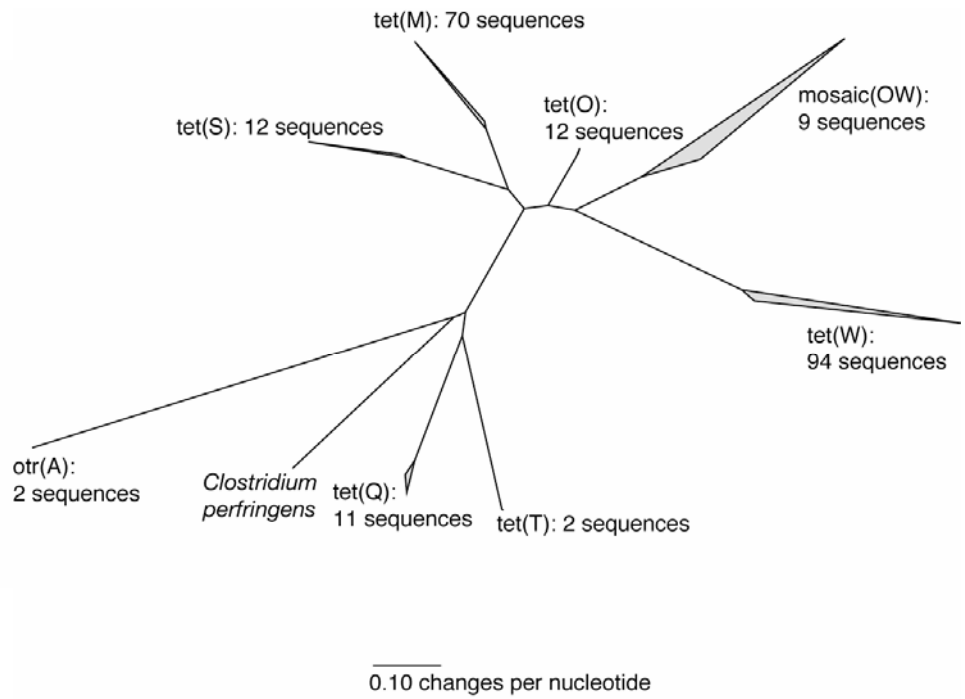
Molecular ecology

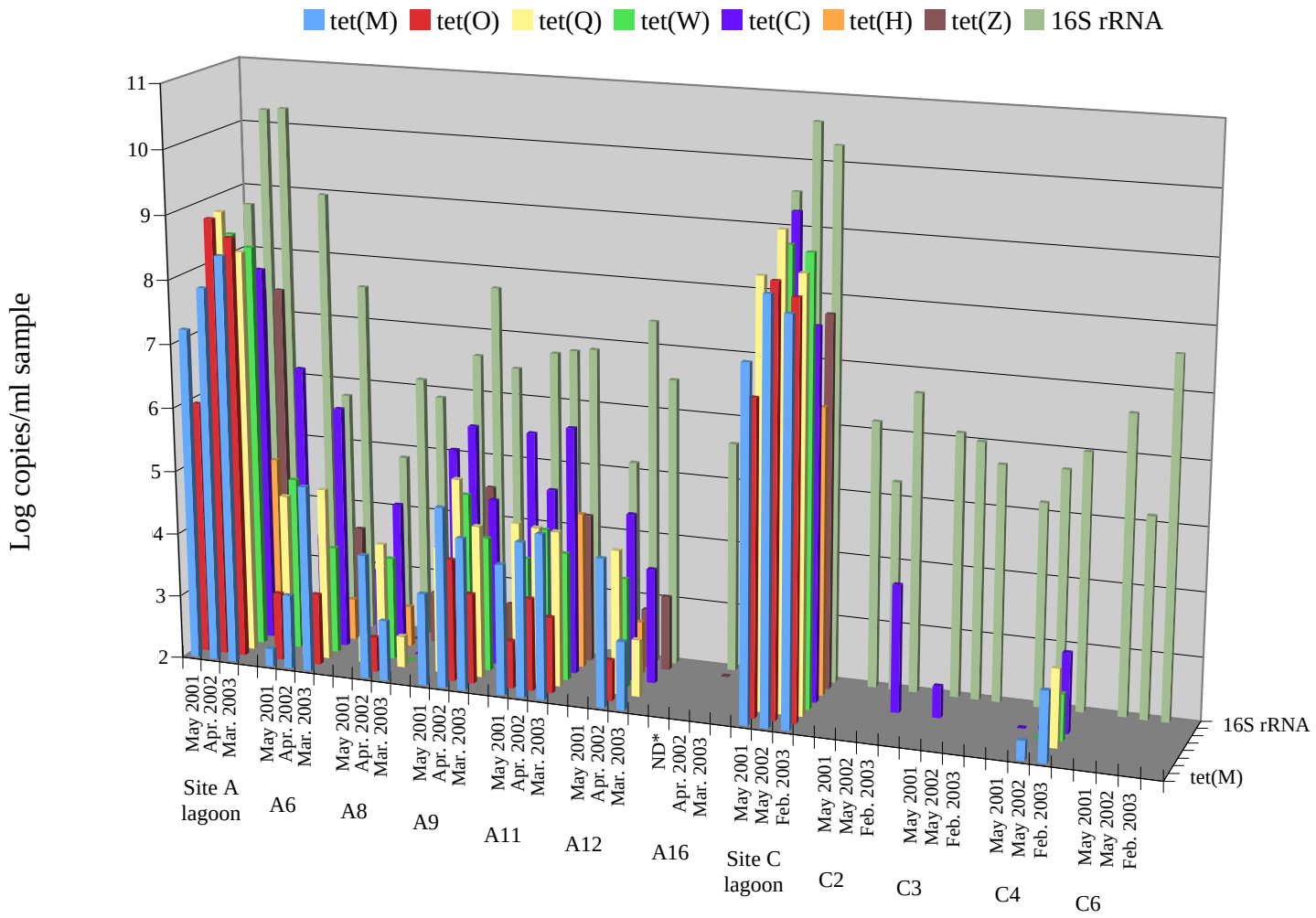
Quantitative PCR for ABR genes

- *Tetracycline (tet M,O,Q,W,C,H,Z)*
- *Erythromycin (erm A,B,C,F,G,Q)*
- *Tylosin (tlr B,D)*





Abundances of tet genes



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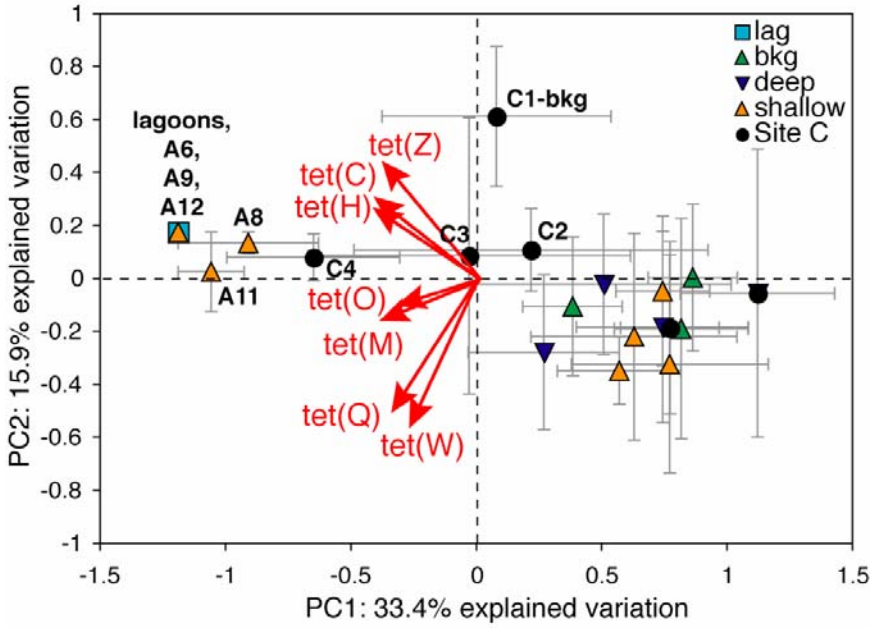
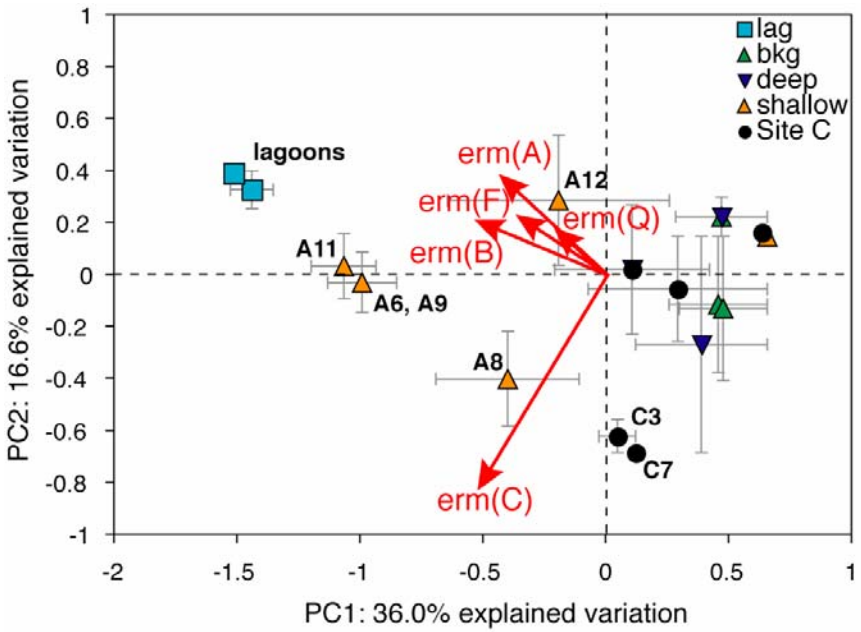
Gene detection frequencies



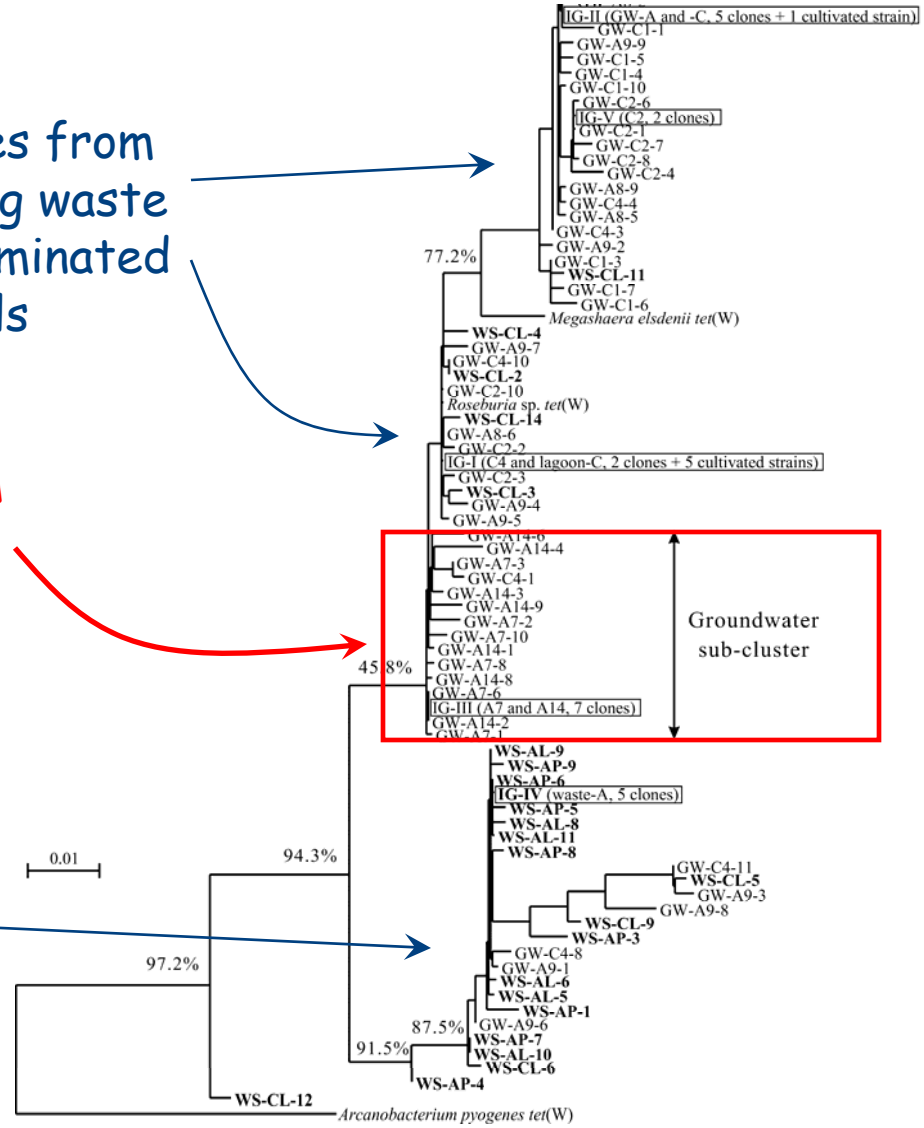


Phylogenetic affiliations of tet(W)

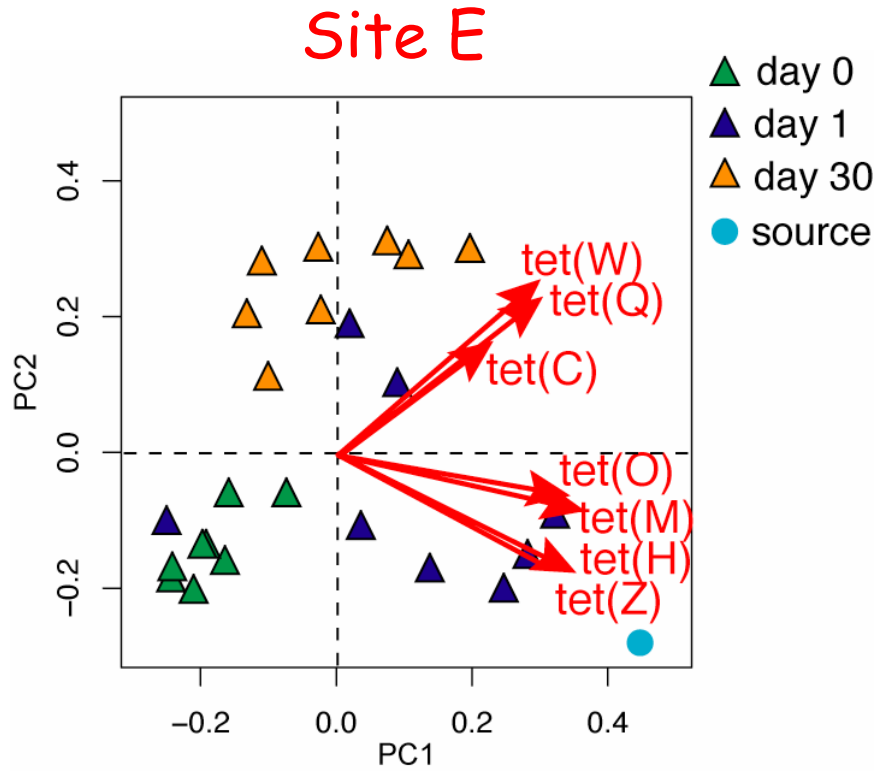
Sequences from lagoon/hog waste and contaminated wells

All sequences from background wells

Primarily sequences from lagoon/hog waste



Dynamics of tet genes in soil



tet(C) and tet(W) remain high after 5 months
tet(C) is still detectable after 18 months

Summary

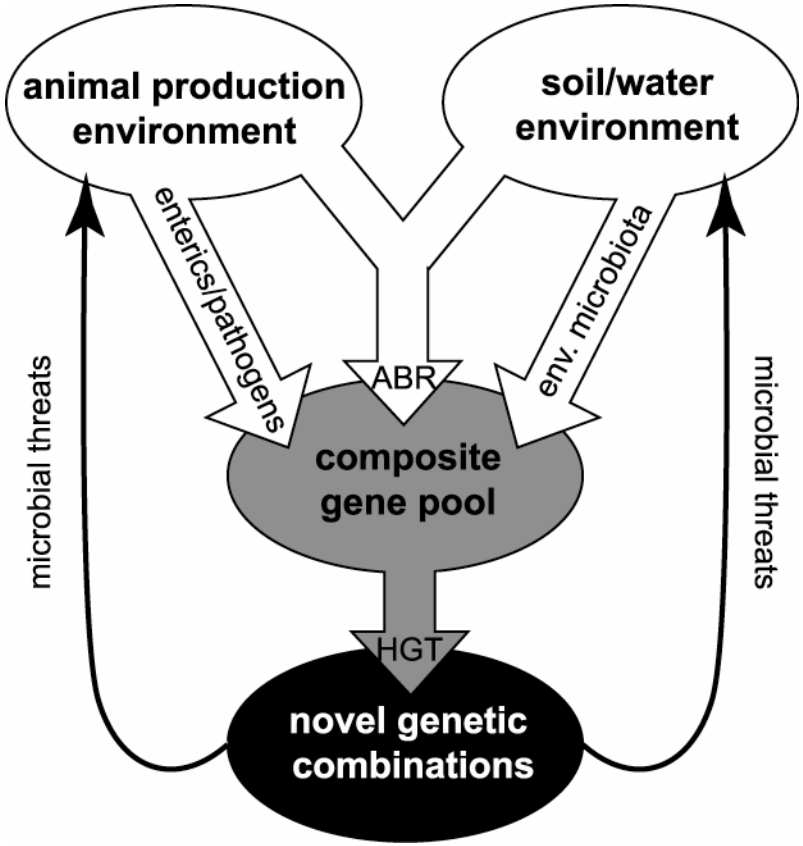
Detection frequencies of ABR genes in groundwater wells indicate contamination

- *Lagoon leakage*
- *Proximity*
- *Groundwater flow*

Phylogeny can discriminate contaminants from "native" ABR genes

Detection of *erm* genes with no erythromycin

Persistence of *tet* in soils

Future directions

Horizontal gene transfer at the interface of agricultural environments