

Environmental microbiology and its application

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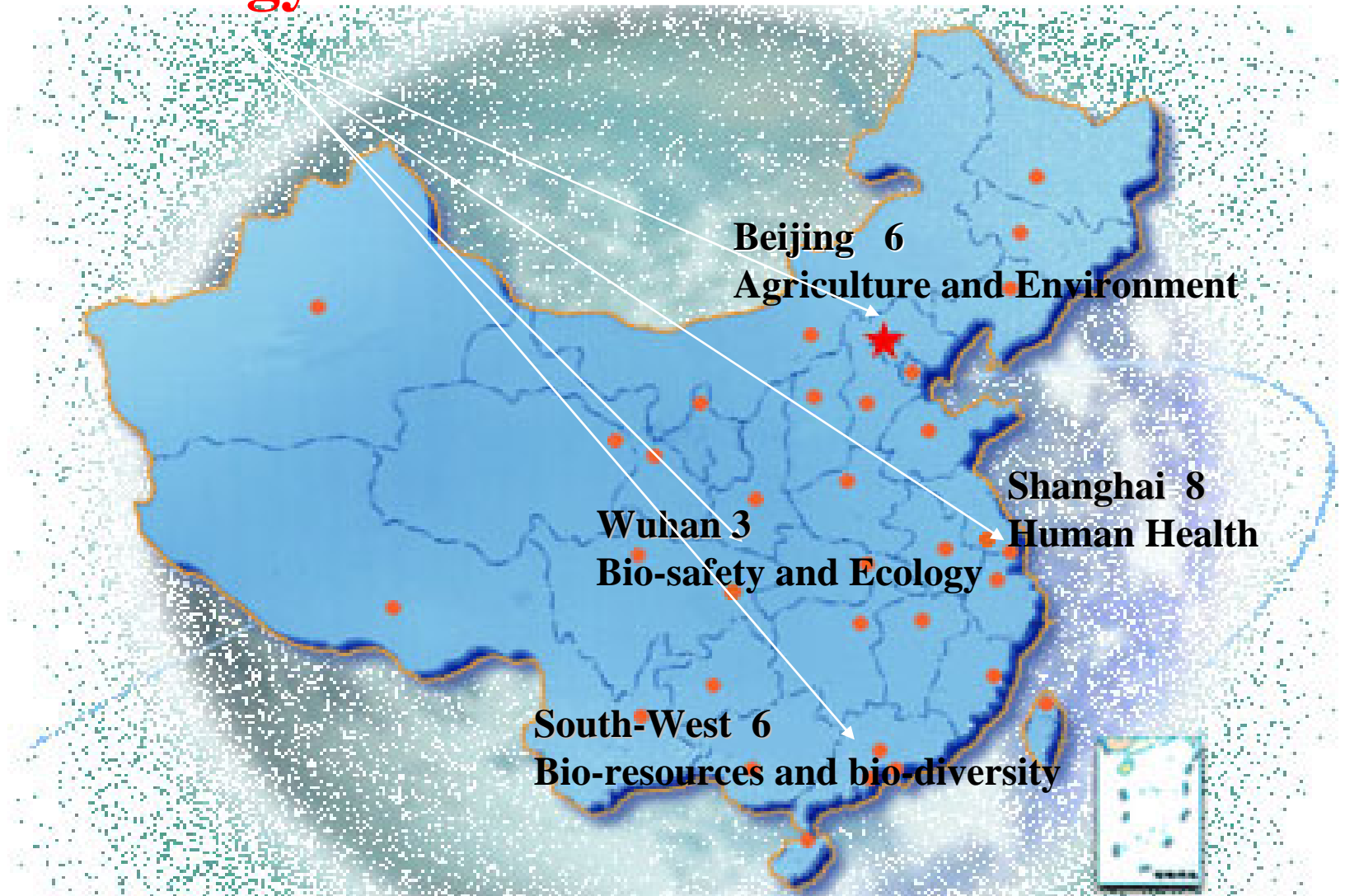
18th, March, 2008





Biology Institutes of Chinese Academy of Sciences

23 Biology Institutes





Wuhan Institute of Virology, CAS

- ◆ **Year founded: 1956**
- ◆ **150 staff members and 200 students**
- ◆ **24 research groups**





Microbes in Our Lives

- ◆ **Microbes (microorganisms)** – Living things that individually are too small to be seen with the unaided eye.
- ◆ They include:
 - ◆ Bacteria
 - ◆ Archaea
 - ◆ Fungi (yeasts & molds)
 - ◆ Protozoa
 - ◆ Algae
 - ◆ Viruses



Outline

- I. Microorganisms and Microbiology**
- II. Microbial degradation of xenobiotics**
- III. Possible Applications**



Extreme Environments and Extremophiles



Black smoker



Permafrost regions



Solar salterns



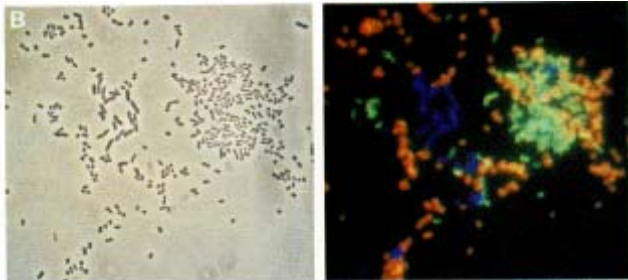
Hot springs

Records for Extremophiles

- ◆ Hottest: 121 °C!
- ◆ Deepest: 2 miles underground in caves
- ◆ Most salty: 5.2 M NaCl (saturation)
- ◆ Most acidic: pH 0.8
- ◆ Most radiation: 1.5 million rads



~99% of the Microbes on Earth are Uncultured



Habitat	Culturability (%)
Seawater	0.001–0.1
Freshwater	0.25
Mesotrophic lake	0.1–1
Unpolluted estuarine waters	0.1–3
Activated sludge	1–15
Sediments	0.25
Soil	0.3

Amann, Ludwig and Schleifer, Microbiol. Rev. 59, 1995



Persistence of Herbicides and Insecticides in Soil

Substance

Time for 75-100% disappearance

Chlorinated insecticide

DDT

4 years

Chlordane

5 years

Organophosphate insecticide

Malathion

12 weeks

Parathion

1 week

Herbicides

2,4-D

4 weeks

2, 4,5-T

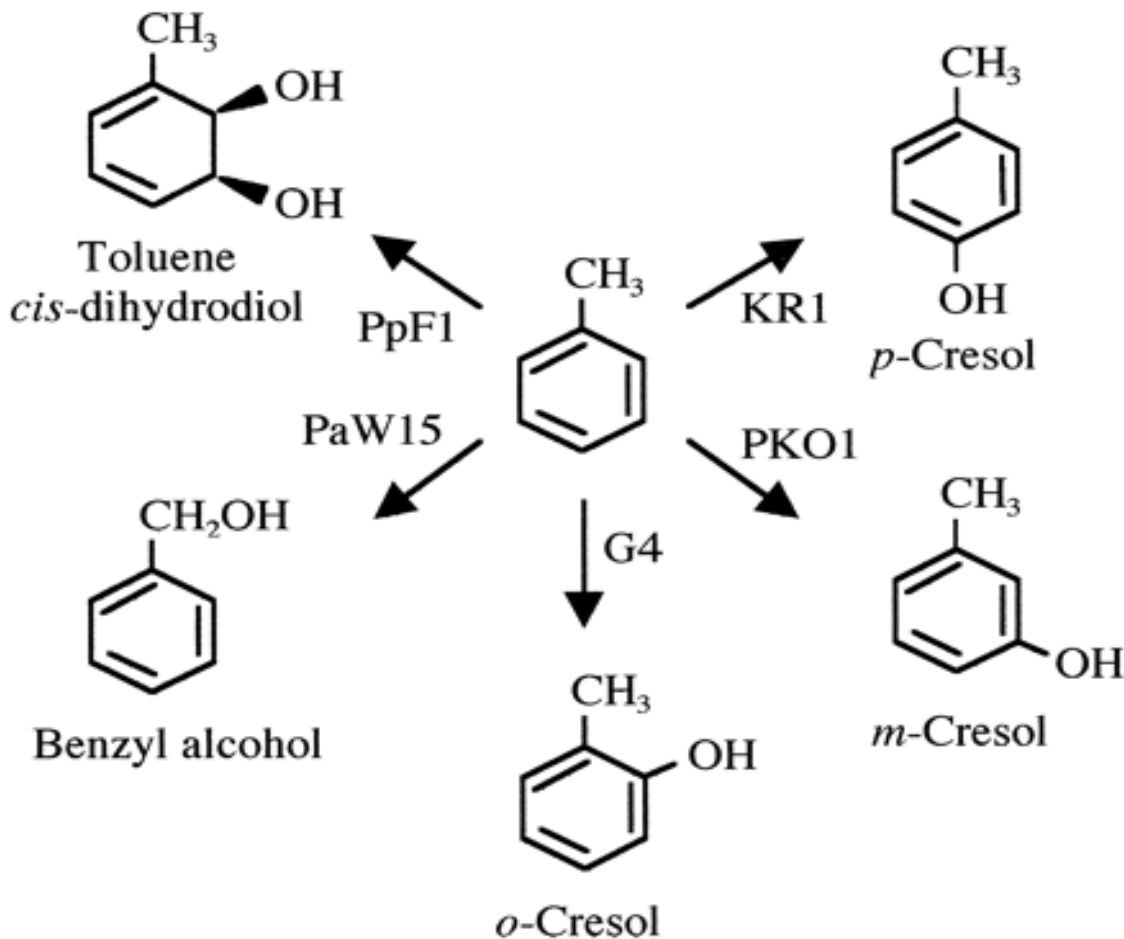
20 weeks

Atrazine

40 weeks



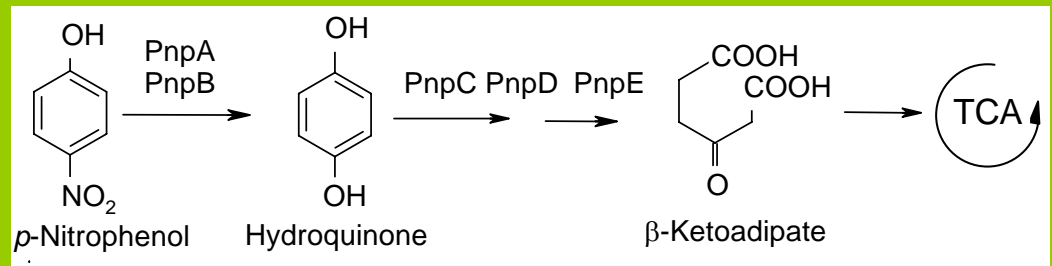
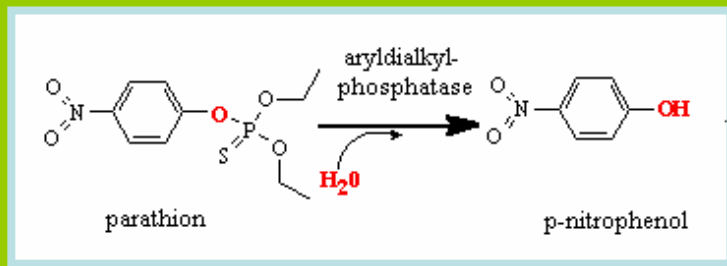
Diversity for the Degradation of Toluene



Initial reactions in the five bacterial pathways for aerobic degradation of toluene in strains *P. putida* F1, *P. putida* PaW15, *B. cepacia* G4, *R. pickettii* PKO1, and *P. mendocina* KR1.



Completely methyl parathion degradation by patchwork assembly of HGT



mph transposon



PNP degradation

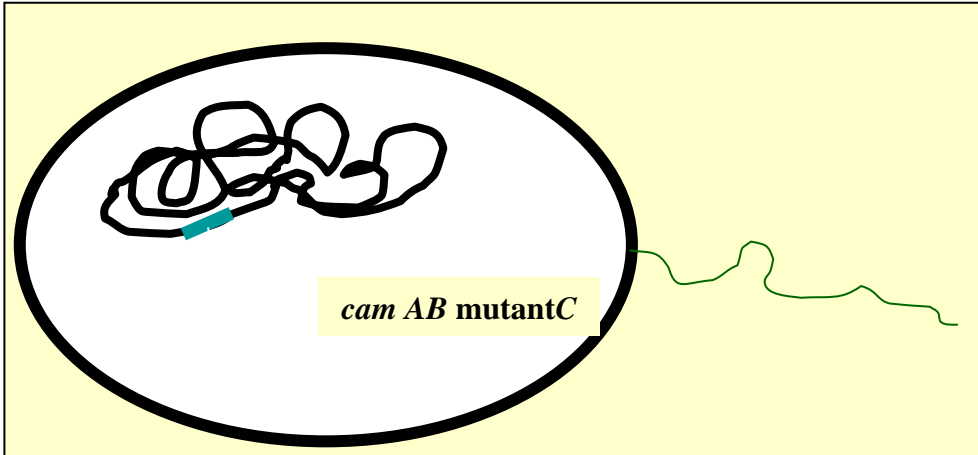
Pseudomonas WBC-3

Liu H et al 2005, Biochem Biophys Res Commun, 334:1107

Zhang et al, 2008, submitted

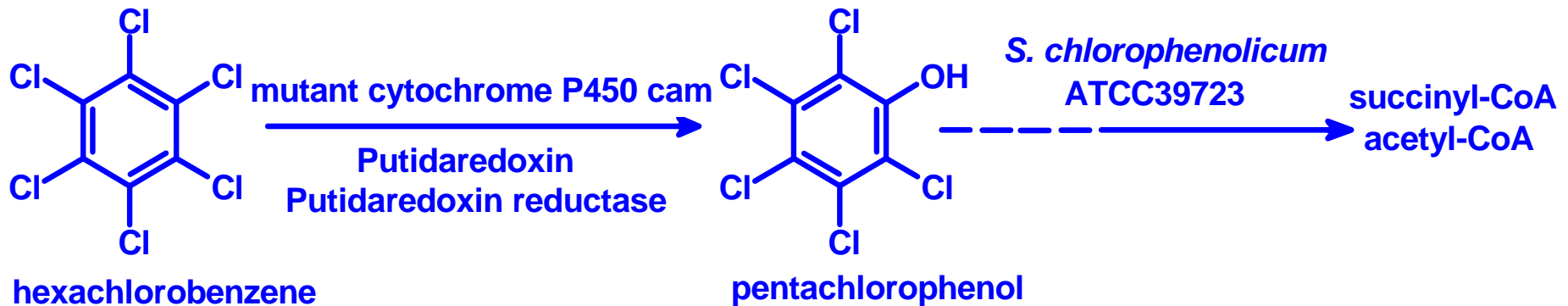


Conversion of *Sphingobium chlorophenolicum* ATCC 39723 to a Hexachlorobenzene Degradator by Metabolic Engineering



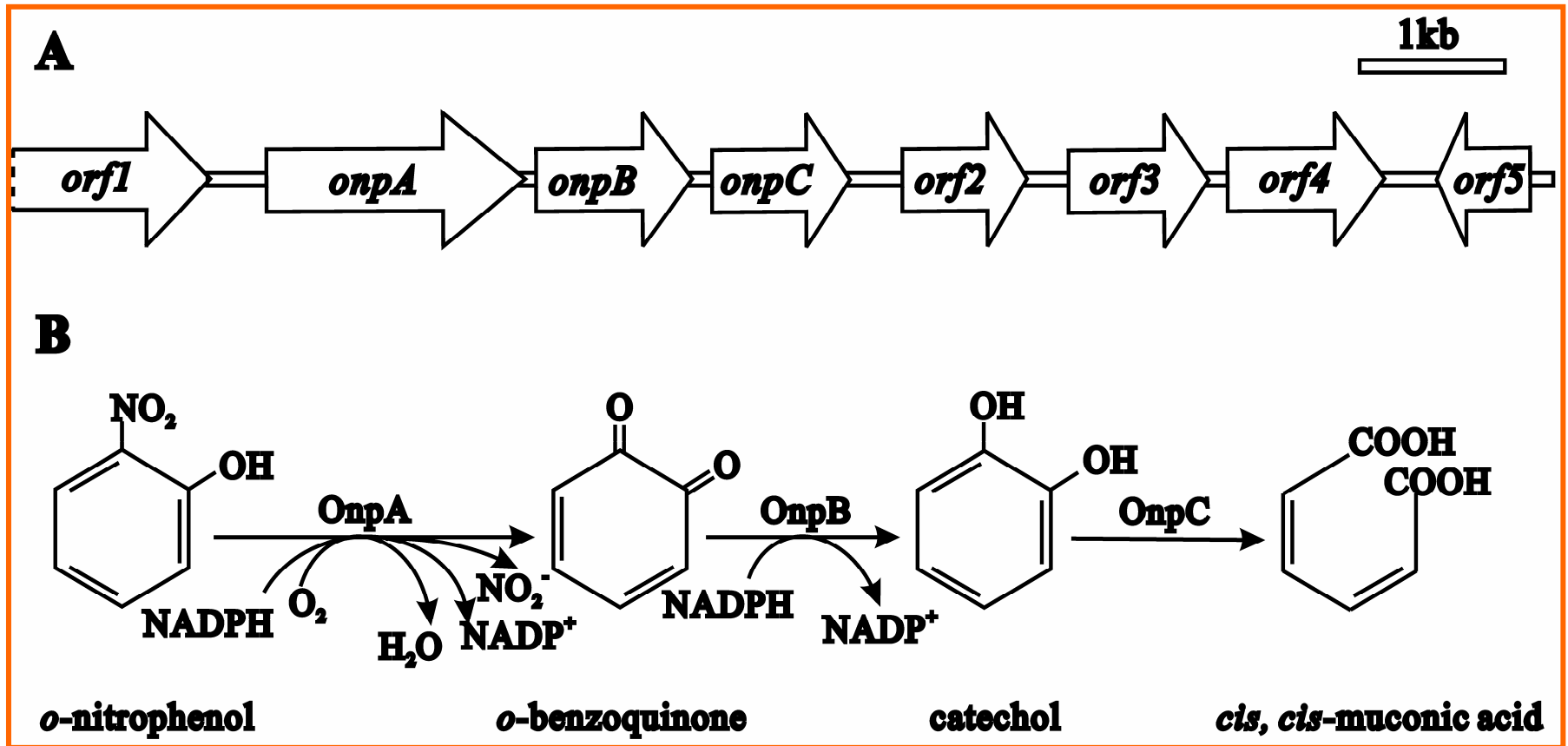
■ Genes encoding mutant cytochrome P-450 enzyme and the physiological electron transfer co-factor proteins were introduced into PCP-degrader ATCC39723 to investigate the possibility of degradation of HCB via PCP.

S. Chlorophenolicum ATCC39723






Catabolic cluster and proposed pathway for the initial reactions of ONP catabolism in *Alcaligenes* sp. strain NyZ215



Xiao et al 2007. J. Bacteriol.189: 6587-6593.



Diversity for the Xenobiotic Degradation Pathways and Enzymes.

Address  <http://umbbd.msi.umn.edu/index.html>

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Publications



171 pathways; 1185 reactions; 1106 compounds; 758 enzymes; 440 microorganism entries; 233 biotransformation rules; 50 organic functional groups; 76 reactions of naphthalene 1,2-dioxygenase; 109 reactions of toluene dioxygenase;

Ellis et al, 2006, *Nucleic Acids Research* **34**: D517-D521

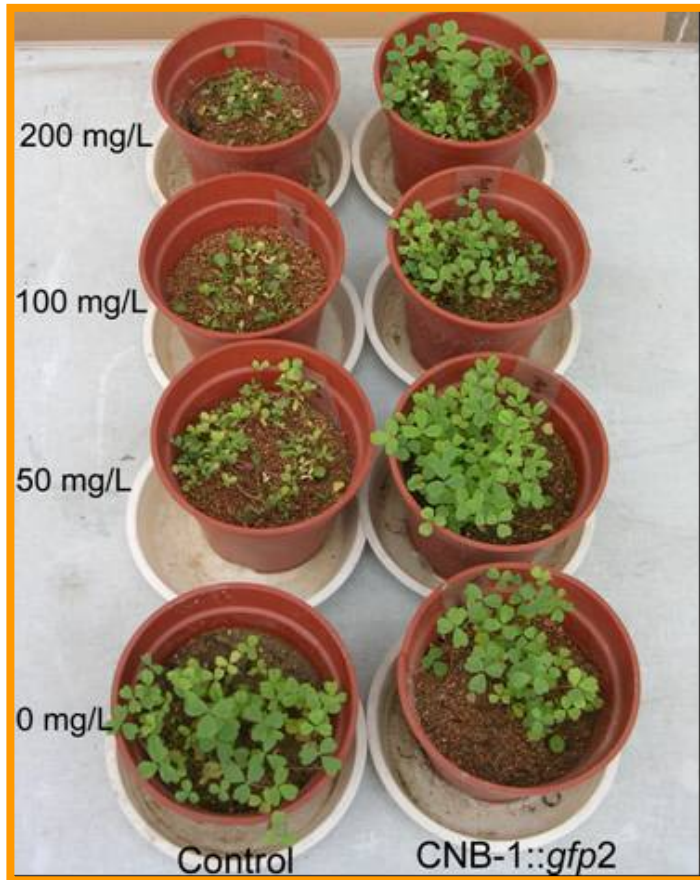


Possible application

- ✓ **Bioremediation** is defined as the process whereby organic wastes are biologically degraded under controlled conditions to an innocuous state, or to levels below concentration limits established by regulatory authorities.



Plant–microbe association for Rhizoremediation of Chloronitroaromatic Pollutants



- Liu et al (2007) *Environ Microbiol* **9**: 465.



Possible application

Biocatalysis and Biotransformation

- Enzymes found in the metabolic pathways with good region- and stereo-selectivity can be devolved for production of fine chemical intermediates.



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*Thanks for your
attention !*



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