Environmental microbiology and its application

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Biology Institutes of Chinese Academy of Sciences

23 Biology Institutes

Beijing 6
Agriculture and Environment

Wuhan 3
Bio-safety and Ecology

South-West 6
Bio-resources and bio-diversity

Shanghai 8
Human Health
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
I. Microorganisms and Microbiology
II. Microbial degradation of xenobiotics
III. Possible Applications
Extreme Environments and Extremophiles

- Black smoker
- Permafrost regions
- Solar salterns
- Hot springs

Recodes 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

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Culturability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater</td>
<td>0.001–0.1</td>
</tr>
<tr>
<td>Freshwater</td>
<td>0.25</td>
</tr>
<tr>
<td>Mesotrophic lake</td>
<td>0.1–1</td>
</tr>
<tr>
<td>Unpolluted estuarine waters</td>
<td>0.1–3</td>
</tr>
<tr>
<td>Activated sludge</td>
<td>1–15</td>
</tr>
<tr>
<td>Sediments</td>
<td>0.25</td>
</tr>
<tr>
<td>Soil</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Amann, Ludwig and Schleifer, Microbiol. Rev. 59, 1995
# Persistence of Herbicides and Insecticides in Soil

<table>
<thead>
<tr>
<th>Substance</th>
<th>Time for 75-100% disappearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorinated insecticide</td>
<td></td>
</tr>
<tr>
<td>DDT</td>
<td>4 years</td>
</tr>
<tr>
<td>Chlordane</td>
<td>5 years</td>
</tr>
<tr>
<td>Organophosphatase insecticide</td>
<td></td>
</tr>
<tr>
<td>Malathion</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Parathion</td>
<td>1 week</td>
</tr>
<tr>
<td>Parathion</td>
<td>1 week</td>
</tr>
<tr>
<td>Herbicides</td>
<td></td>
</tr>
<tr>
<td>2,4-D</td>
<td>4 weeks</td>
</tr>
<tr>
<td>2, 4,5-T</td>
<td>20 weeks</td>
</tr>
<tr>
<td>Atrazine</td>
<td>40 weeks</td>
</tr>
</tbody>
</table>
Diversity for the Degradation of Toluene

Evolution of Catabolic Pathways for Degradation of 2,4-Dinitrotoluene

Organization and evolution of the 2,4-DNT gene cluster in *Burkholderia cepacia* R34. (Johnson GR and Spain JC, Appl Microbiol Biotechnol 2003, 62:110-123)
Completely methyl parathion degradation by patchwork assembly of HGT

Zhang et al, 2008, submitted
Conversion of *Sphingobium chlorophenolicum* ATCC 39723 to a Hexachlorobenzene Degrader 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.

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

Diversity for the Xenobiotic Degradation Pathways and Enzymes.

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;

Possible application

✔ **Bioresmediation** 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

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.
Acknowledgements

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Thanks for your attention!