

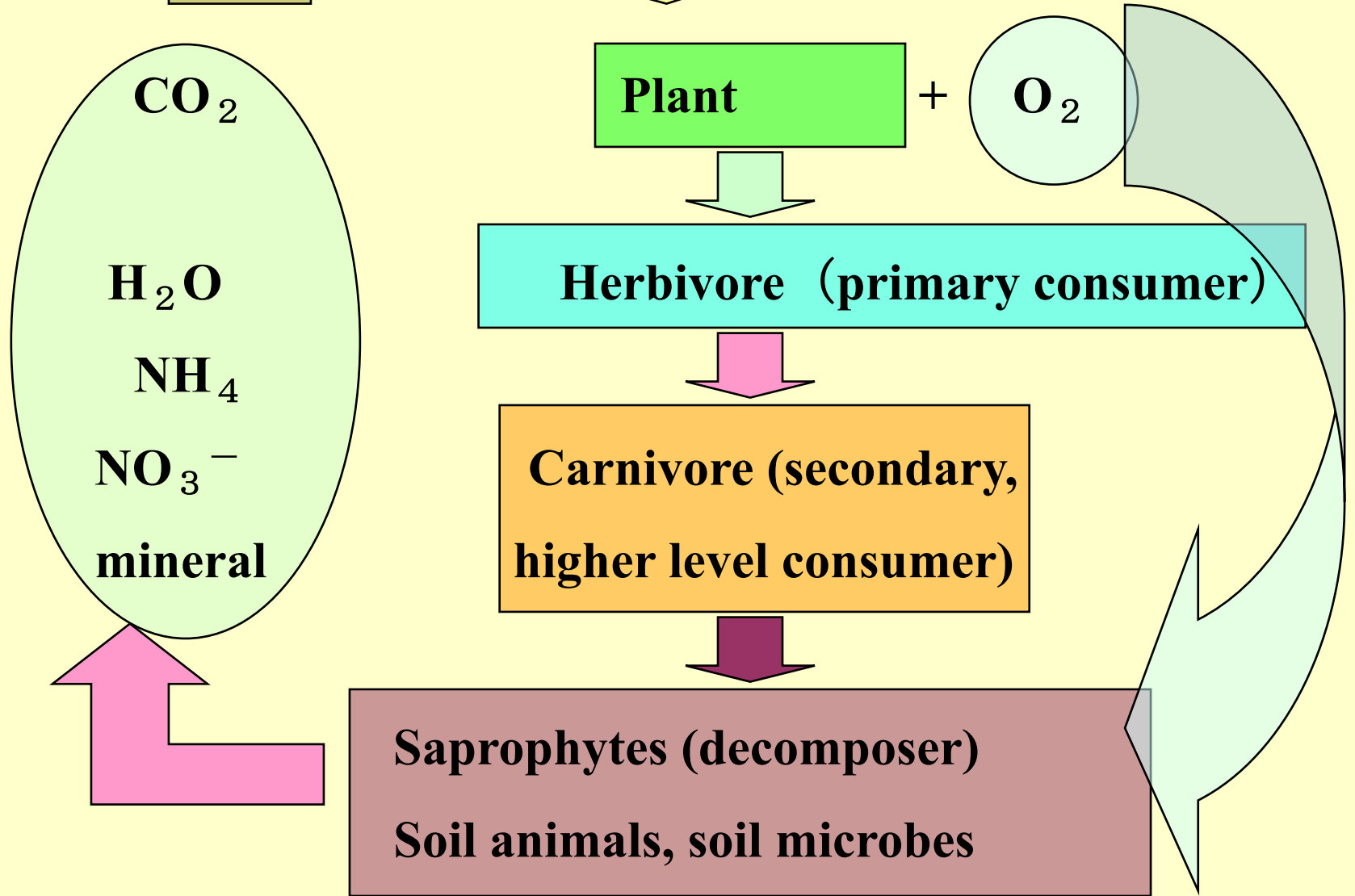
# Soil organisms

**Kinds, roles and inter-  
relationships**

**Kiyoshi Tsutsuki**

**<http://timetraveler.html.xdomain.jp>**

**Light energy**



**Importance of saprophytic organisms**

# Organisms in surface soil

Plant roots

Mammals

Soil animals

Soil microbes

Biomass of soil organisms /1 ha  
reaches several tons:

5 t / ha,    0.5kg / m<sup>2</sup>

**Biomass of soil organisms (some t / ha) is almost equivalent to the yield of crops harvested annually from the land, or to the weight of domestic animals bred on the land.**

Yield of rice: ca. 5 t /ha = 500 kg /10 a

Breeding density of cows:

1–2 heads / ha = 1.5 t / ha

# **Role of soil to the crowd of soil organisms:**

**Moisture, Oxygen, Temperature,  
Mineral nutrition, Supply of  
organic matter**

# **What soil owes to the crowd of soil organisms:**

**Decomposition of organic matter,  
emission of carbon dioxide, liberation  
of mineral nutrients**

**Creation of soil structure**

**Supply of fertile plant growth  
environment**

**Soil animals**  
**(soil fauna)**

# **Macrofauna**

**Animals sized  $>2\text{mm}$  or  $10\text{mm}$**

**Earthworms, Enchytraeina,  
ants, Millipede, Centipede, etc.**

**Population of earthworms :**

**$3000-250,000 /10\text{a}$ ,  $3-250 /\text{m}^2$**



# Function of earthworms

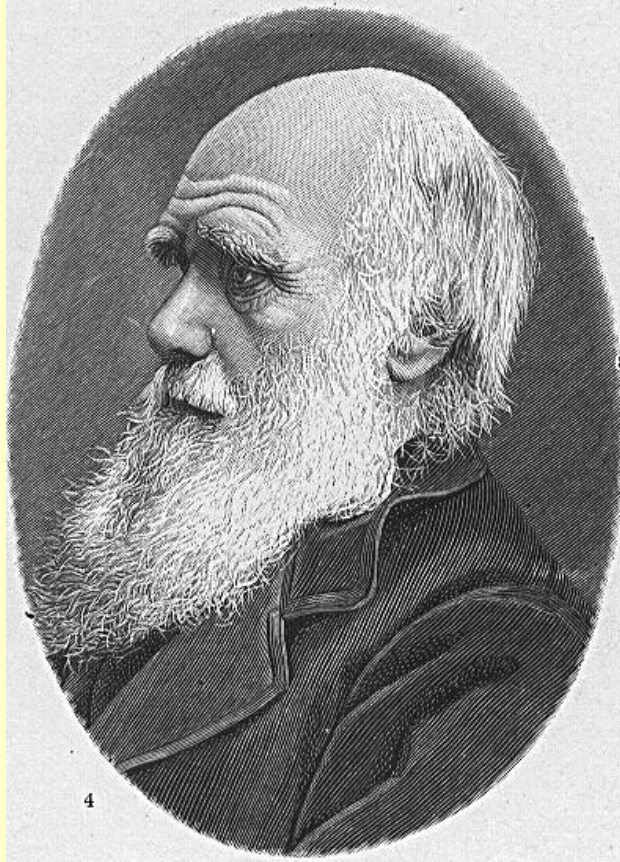
**Amount of soil passing through the body of earthworm :**

**4t / 10a annually**

**In 30-50 years, all the soil in the plowed layer passes through the body of earthworms.**

$$200 \text{ t} / 4 \text{ t} = 50 \text{ years}$$

# Charles Darwin



“The Formation of  
Vegetable Mould  
through the Action of  
Worms, with the  
Observation of their  
Habits” (1881)

Japanese translations:

S. Yata (1949), H. Watanabe  
(1994) (平凡社)

# Clods of the feces of earthworms (Baybay, Leyte, Philippines)



## **Functions of soil animals:**

### **Eating and crushing plant remains and animal feces**

- **Decomposability of plant remains increases after eaten and crushed by soil animals.**
- **Animal feces are first eaten and decomposed by the larva of insects (eg. Dung beetles and flies).**

# **Organic matter decomposition by soil animals**

**Temperate region: Arthropods and earthworms**

**Tropics and subtropics: Termites**

**Sub-boreal needle forest:  
Enchytraeina**

# Mesofauna

**Size: 0.2-2 mm ~ 10 mm**

**Collembola (spring tails), mites, nematodes**

**Population:**

**Collembola and mites: 50,000-80,000 /m<sup>2</sup> in forest floors.**

**Nematoda: (saprophytic, predatory, parasitic)**

**1.30 million /m<sup>2</sup> in the forest,**

**50,000-80,000 /m<sup>2</sup> in cultivated lands.**

# **Microfauna**

**Size: < 0.2mm**

**Protozoa:**

**Amoeba, Ciliates, Flagellate**





**Collembola (アカトビムシ)**





**Collembola (マルトビムシ)**



**Oribatid (ササラダニ)**



**Prostigmata (ケダニ)**





**Isopoda, sow bug (ワラジムシ)**



**Lithobius (イシムカデ)**



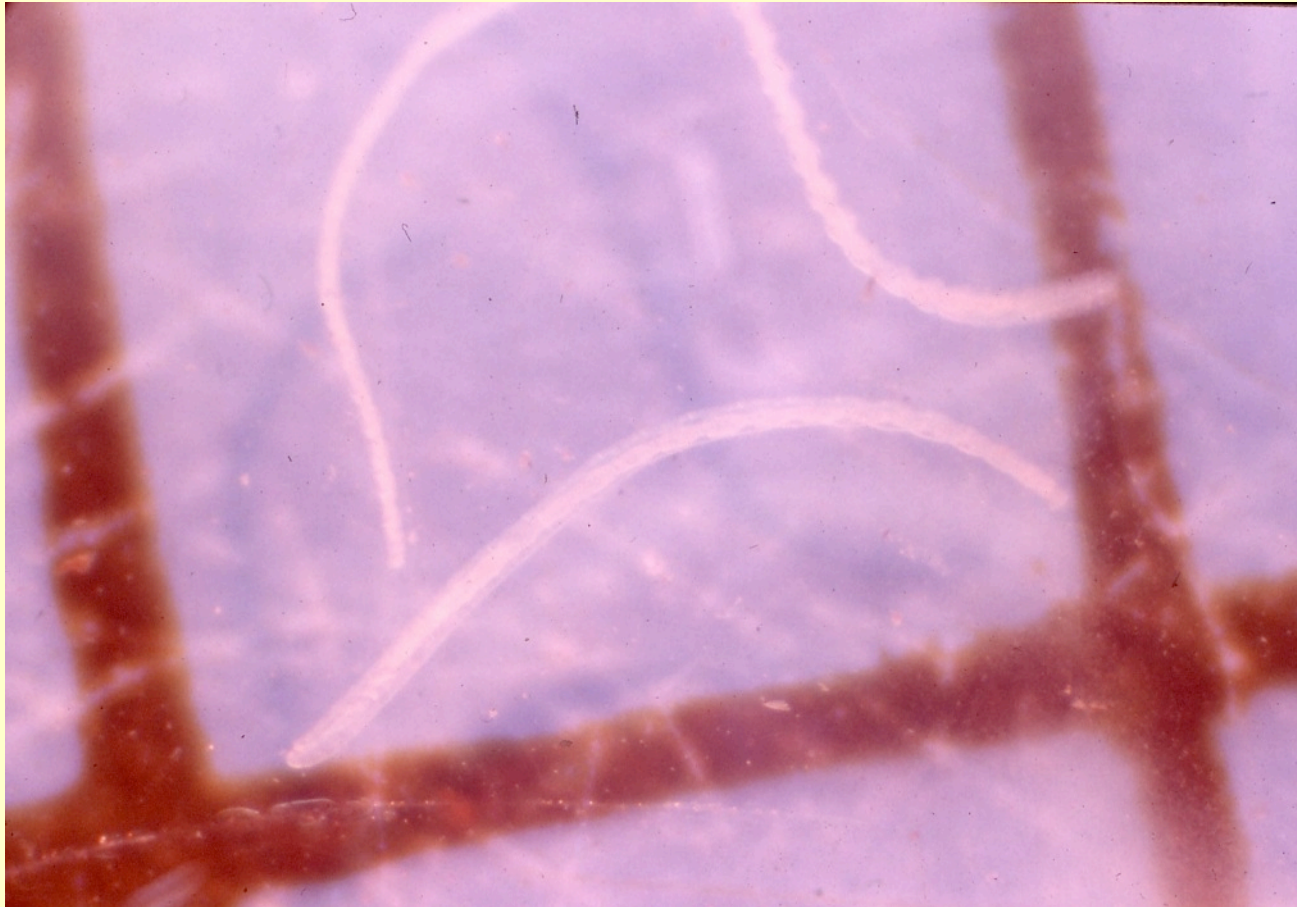
**Larva of millipede**  
(ヤスデ綱幼虫)





**Larva of Diptera (flies)**

双翅目(ハエ目)幼虫



**Enchytraeina (ヒメミミズ)**





*Pratylenchus penetrance*  
(キタネグサレセンチュウ)



**Nematodes isolated from OUAVM fields.**

Pratylenchus penetrance  
(キタネグサレセンチュウ)



*Lumbricus rubellus*  
(ツリミミズ)



Length: 6-10 cm

Collected from compost

Living depth: 10-25 cm

*Amyntus agrestis*  
(フトミミズ)



Length: 8-20 cm

Collected from compost

Living depth: 10-50 cm

## Population of soil animals / m<sup>2</sup> (Kitazawa, 1976)

kinds	Needle forest	Mulberry field	Upland field
Macrofauna	<b>73</b>	<b>16</b>	<b>19</b>
Enchytraeina ( $\times 10^3$ )	<b>150</b>	<b>6.5</b>	<b>3.7</b>
Collembola ( $\times 10^3$ )	<b>76</b>	<b>5.0</b>	<b>9.3</b>
Mites ( $\times 10^3$ )	<b>53</b>	<b>8.1</b>	<b>5.8</b>
Nematodes ( $\times 10^5$ )	<b>13</b>	<b>7.0</b>	<b>1.4</b>

# Soil microbes

**Bacteria, Actinomycetes,**

**Fungi, Algae**

# **Classification of organism by the method to obtain carbon.**

## **From organic matter....**

organotrophs, heterotrophs

## **From carbon dioxide .....**

lithotrophs, autotrophs

# Classification of organism by the method to obtain energy.

From the light .....

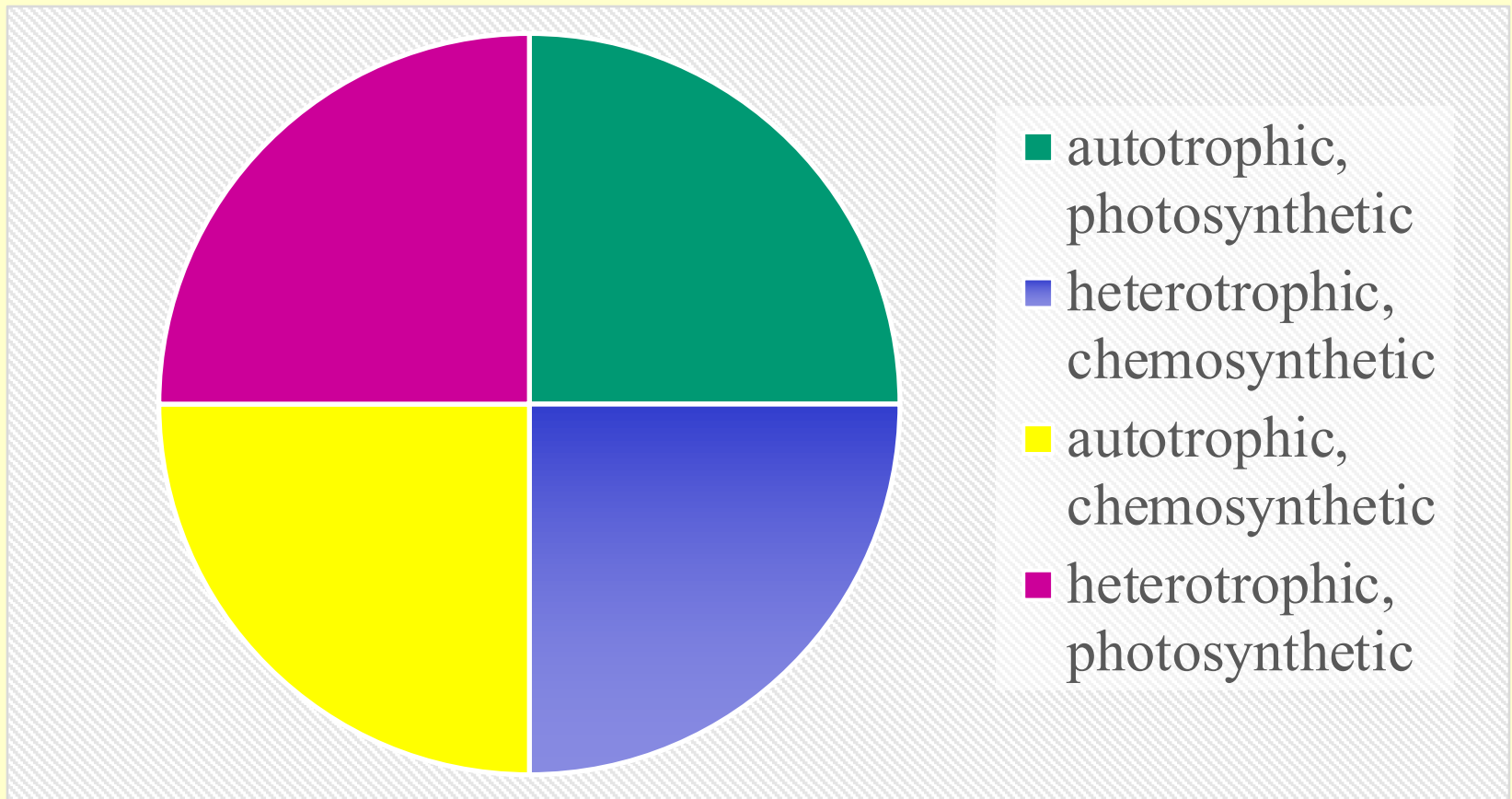
**Photosynthetic organisms**

From the chemical compounds, such as methane, hydrogen sulfide, hydrogen gas, etc. ...

**Chemosynthetic organisms**



# Classification of organisms according to the types of metabolism



# Classification of organisms according to the types of metabolism

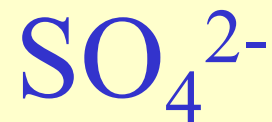
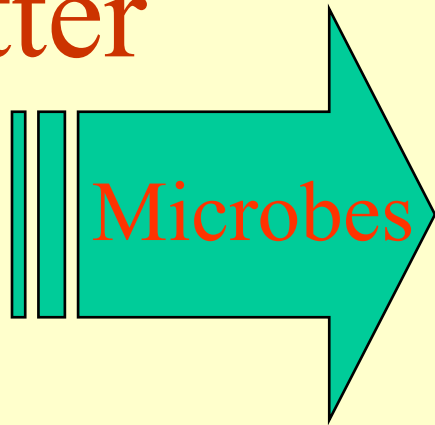
Types of metabolism	Members of the group
Autotrophic, Photosynthetic	Higher plants, algae, Chromatiales bacteria, Chlorobiales bacteria
Heterotrophic, Chemosynthetic	Animals, fungi, actinomycetes, most of bacteria
Autotrophic, Chemosynthetic	Ammonium oxidizing bacteria (Nitrosomonas), Nitrite oxidizing bacteria (Nitrobacter), Iron bacteria, Hydrogen bacteria, Sulfur oxidizing bacteria (Thiobacteria)
Heterotrophic, Photosynthetic	Purple bacteria (Rhodobacteria, Blastochloris)

# Function of soil microbes

- **Mineralization of organic matter**
- **Secretion of soil enzymes**
- **Decomposition and purification of harmful organic matter**
- **Symbiotic relationship with plants**
- **Antagonism (competition) with disease causing germs**

# Mineralization of organic matter

Organic  
matter

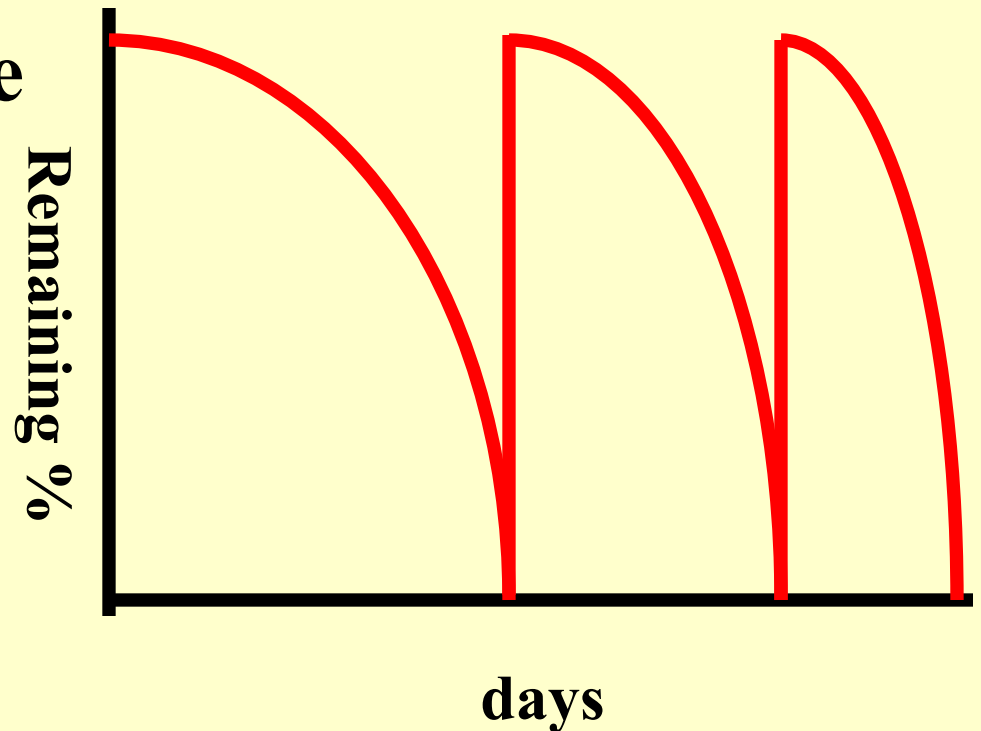


# Secretion of soil enzymes

- Cellulase
- $\alpha$ -Glucosidase
- $\beta$ -Glucosidase
- Protease
- Phosphatase
- Lipase

# Decomposition and purification of harmful organic matter

- **Trichloroethylene**
- **PCB**
- **Dioxin**
- **Pesticides**



**Direct decomposition and co-metabolism**