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Dioxin pollution in Vietnamese hotspots and degradation activity of isolated bacteria in microcosms

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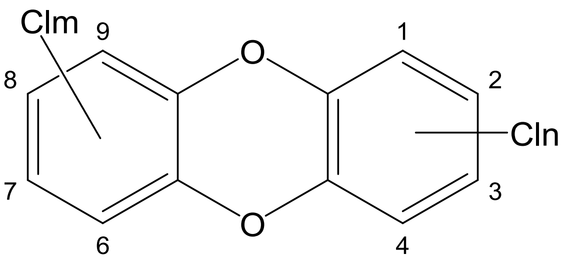
Formation and behavior of dioxins

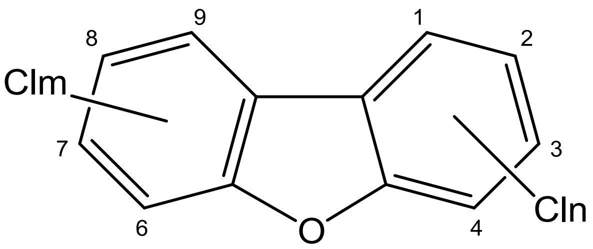
- Pesticide manufacture
- Paper manufacture
- Waste incineration
- Forest fire



Polychlorinated dibenzo-*p*-dioxins (PCDDs)

Behaviour of dioxins in soil

- Adsorbed on soils
- Very resistant in the environment
- Accumulate in fat tissues and concentrate in the food chain.



Polychlorinated dibenzofurans

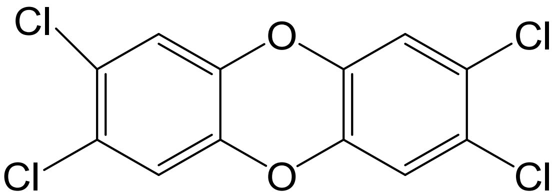
PCDFs

Effect of dioxins on human health

- Cause cancer, birth defects, reproductive, developmental and immunological problems.

Agent Orange and Dioxins in Vietnam

- Agent Orange (AO) defoliant: mixture 2,4 dichlorophenoxyacetic acid (2,4-D) and 2,4,5 tricholorophenoxyacetic acid (2,4,5-T)
- 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) in Agent Orange: 0.05 to 50 mg/L
- 72 M liters of AO sprayed



2,3,7,8-TCDD the most toxic among PCDDs

Objectives

- Determine the dioxin residue in soils/sediments at hotpots.
- Examine the potential of microbial detoxification of dioxin-polluted soils/sediments sprayed with Agent Orange.

Sampling sites

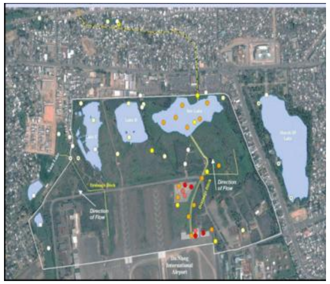
- At heavily sprayed area, Cua of Quang Tri province: sediments of water reservoirs, ponds and top soils of paddy and upland fields.
- At Aluoi of Hue: soils of former military airbase Aso, soils of paddy and upland crop field, sediments of lake and ponds.
- Da Nang former military airbase
- Bien Hoa former military airbase

Cua, Quang Tri prov.

A Luoi, Hue

Da Nang, former military airbase

Bien Hoa,former military airbase



Dioxin residues in soils/sediments at study sites

A Luoi: 2,3,7,8-TCDD at former air-base:

- Topsoil in A Luoi air-base: ~ 900 pg/g
- Duck and fish fats: 40-60 pg/g
- Human blood: 14-40 pg/g

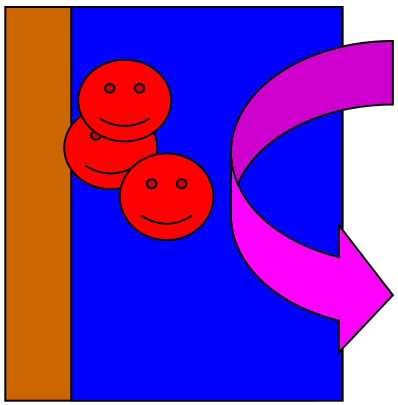
(Source: Dwernychuk & Hoang D.C, 2002)

Da Nang and Bien Hoa former military air-bases pg/g

Site	**Sample type**	**2,3,7,8-TCDD**
Da Nang	Sediment	271
	Soil 01	633
	Soil 02	7095
Bien Hoa	Sediment	100
	Soil 01	115

Microbial detoxification of dioxins

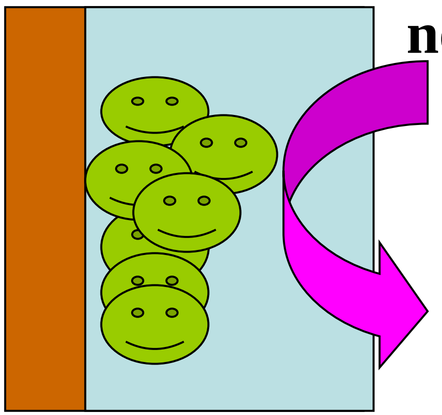
Anaerobic condition



High chlorinated dioxins

less chlorinated or non-chlorodioxin

Aerobic condition



non-, mono- or di-chlorodioxins

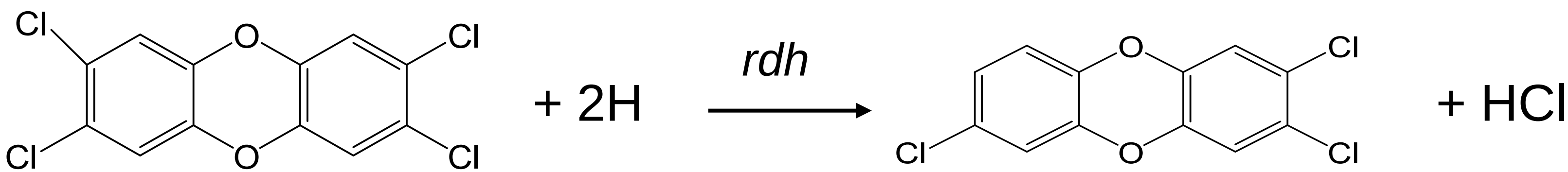
CO_2 + H_20

Reductive dechlorination done by *Dehalococcoides*:

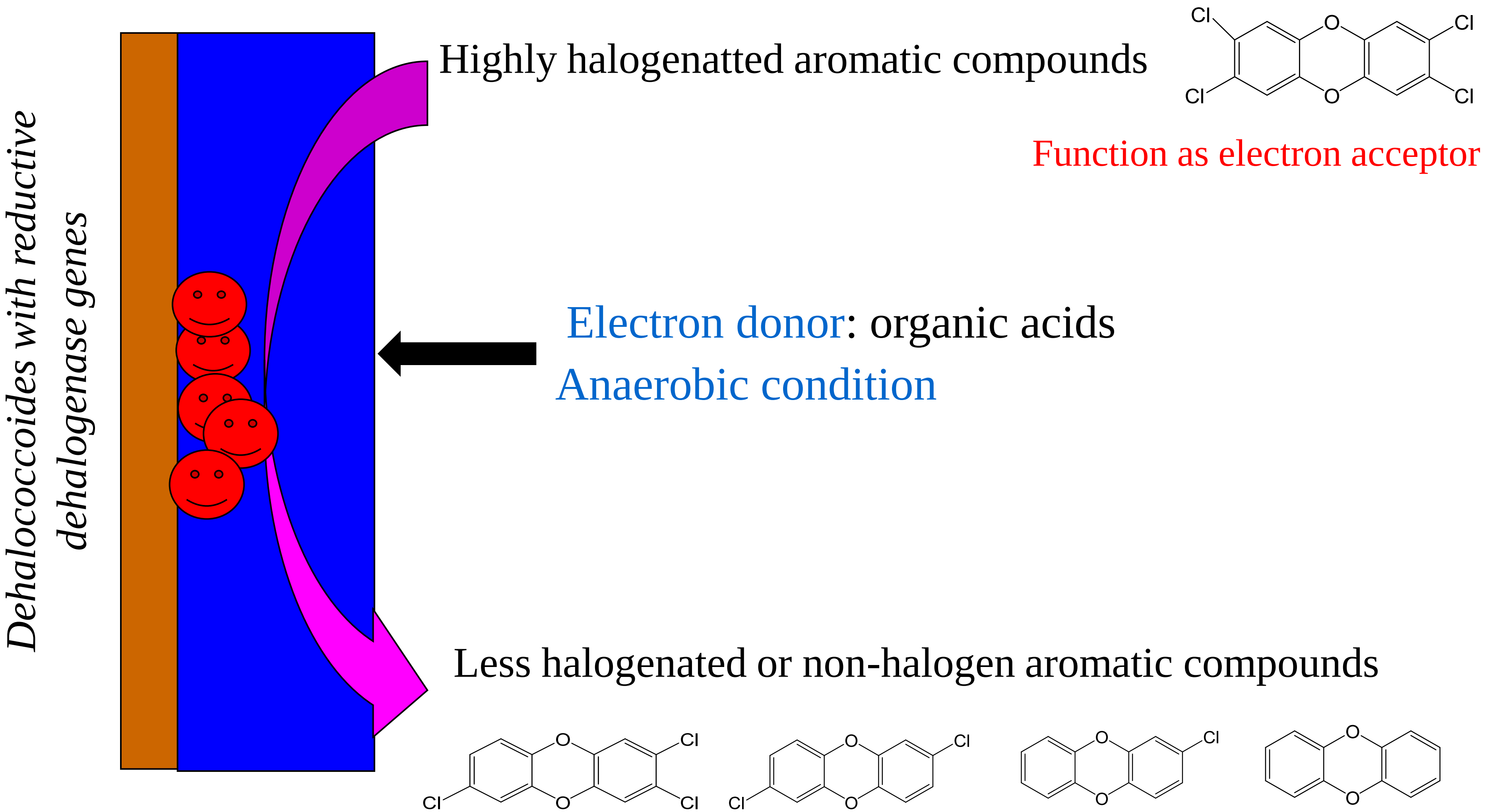
Degradation (breaking the aromatic ring)

Electron donor: organic acid → H_2

Electron acceptor:



Reductive microbial dehalogenation of halogenated aromatic compounds



Anaerobic microcosm set up

Examine 1,2,3,4-TCDD / 2,3-DCDD dechlorination:

spike soils/sediments with:

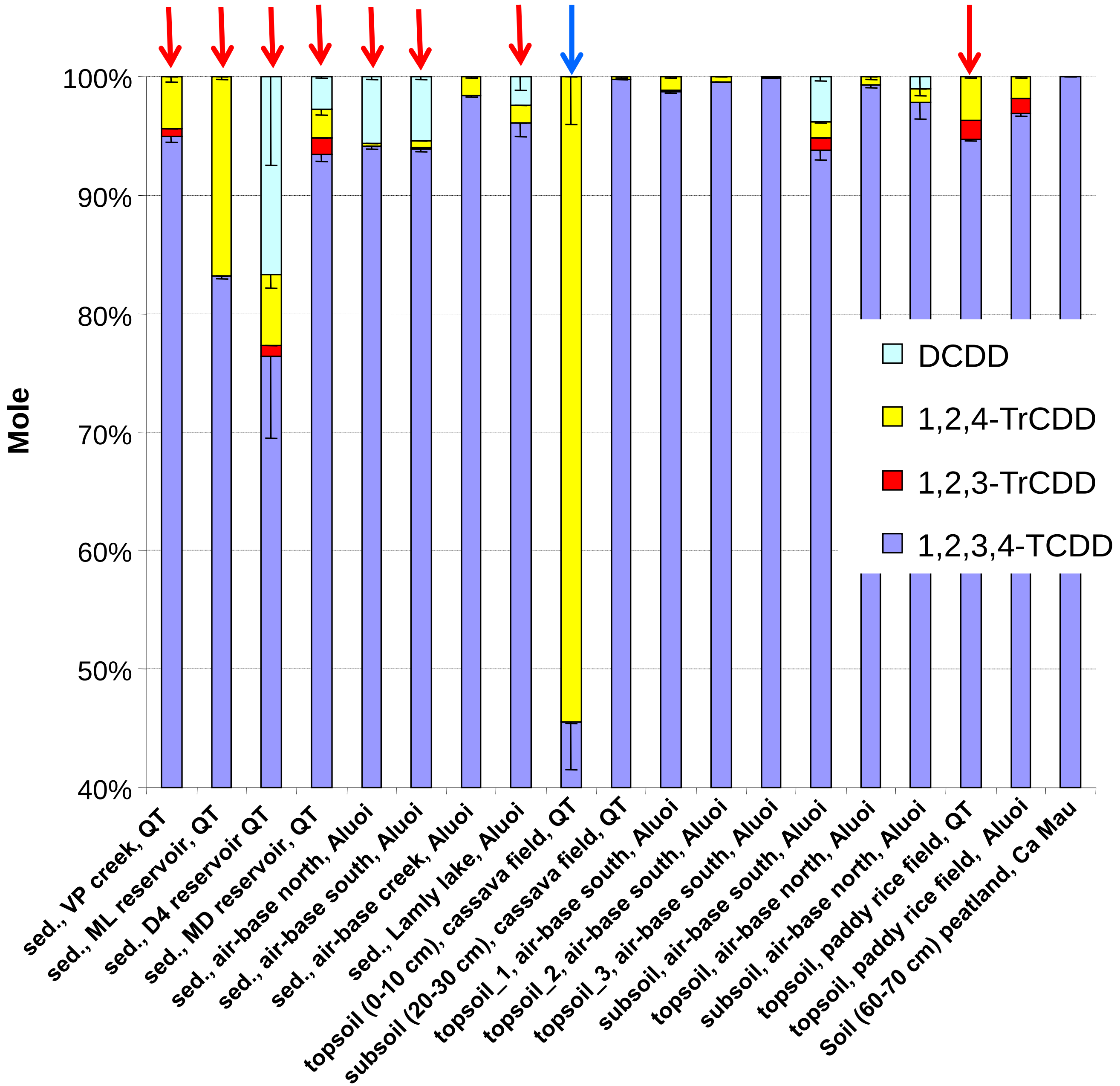
+ 1,2,3,4-TCDD or 2,3-DCDD

+ electron donors (lactate + butyrate + pyruvate + propionate)

Examine dechlorination of 2,3,7,8-TCDD:

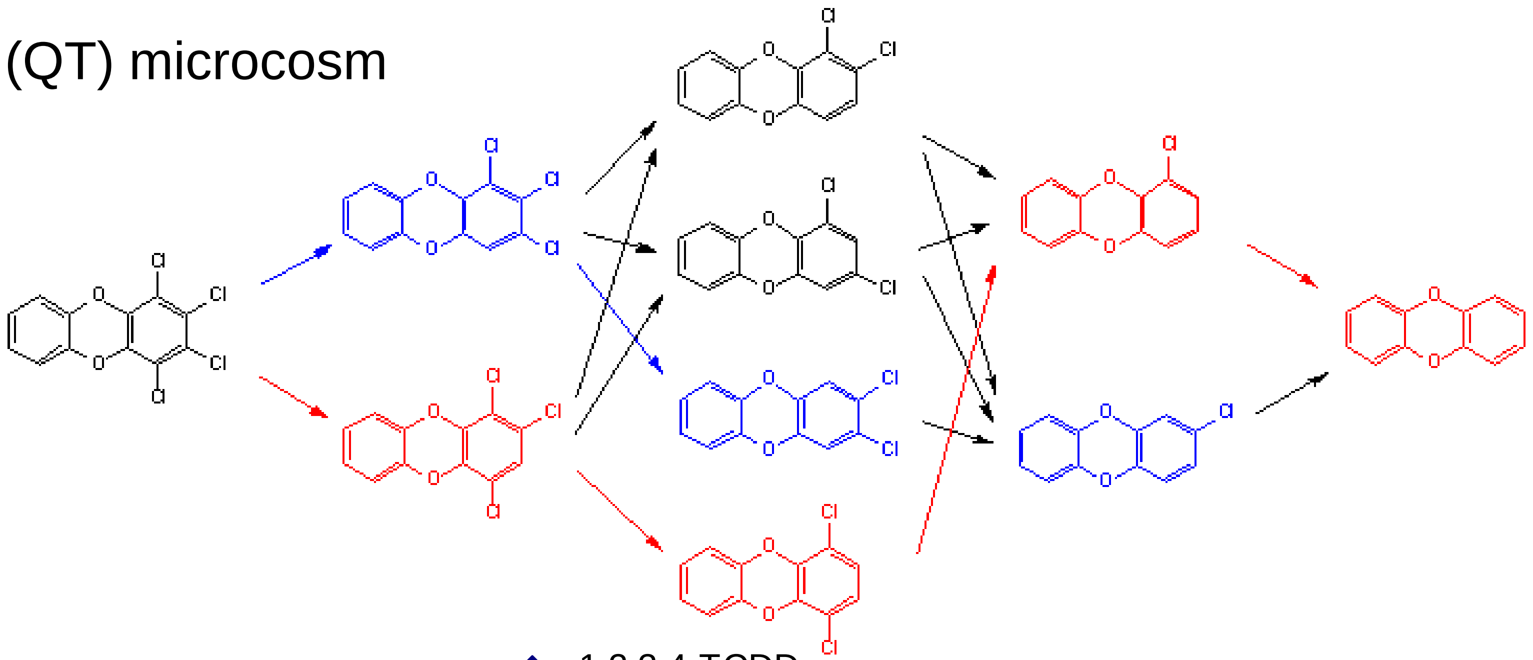
Spike 2,3,7,8-TCDD to positive 2,3-DCDD dechlorinating microcosm.

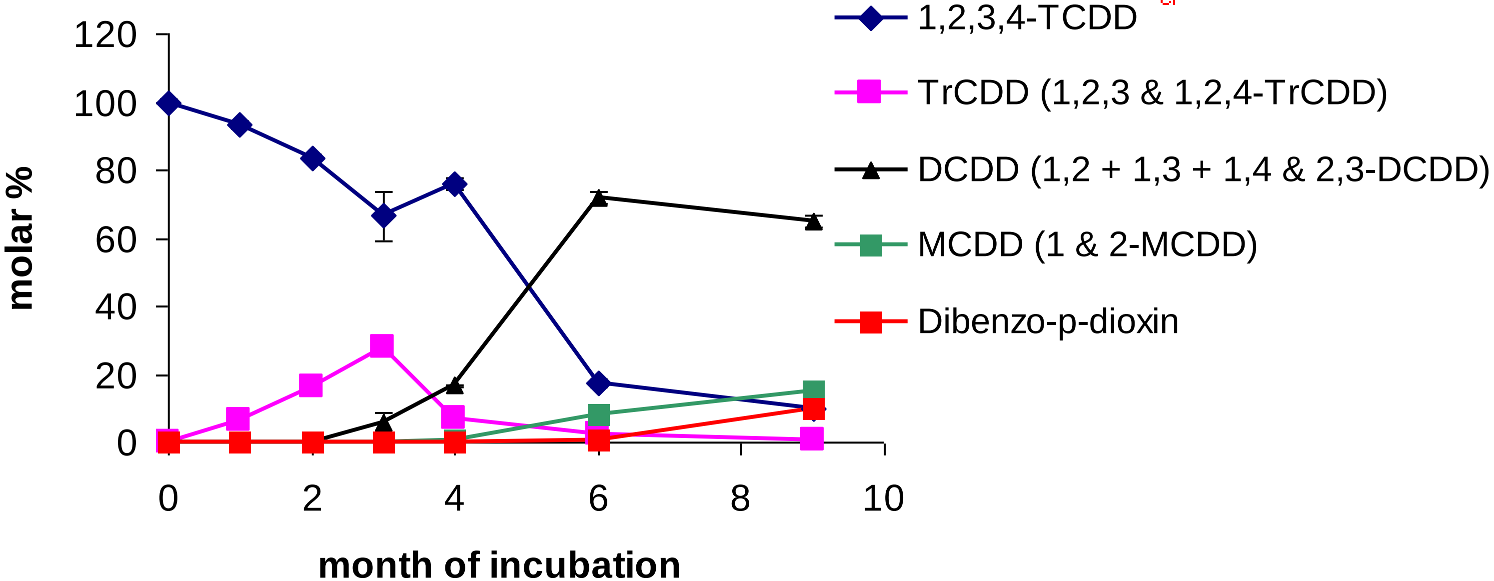
Dechlorination activity after 4-month incubation



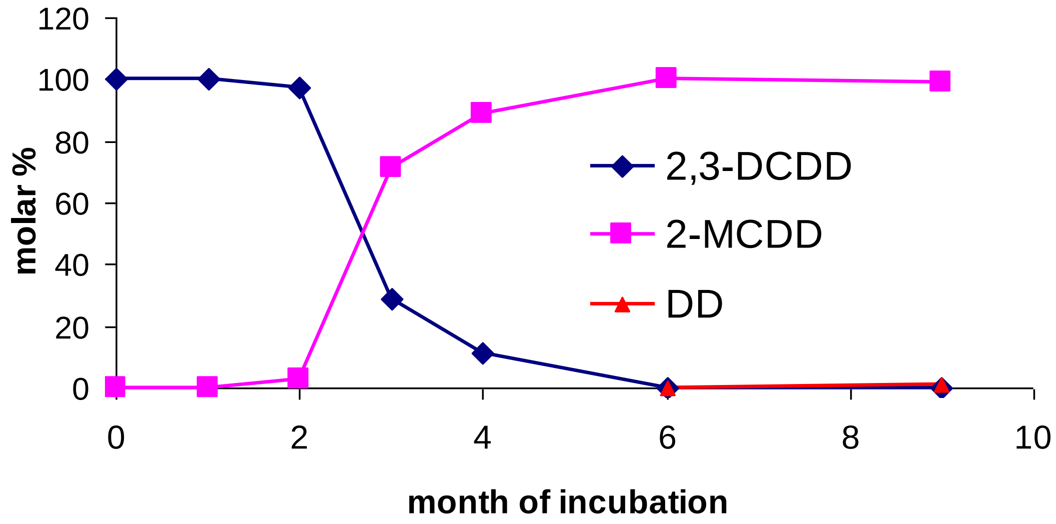
Lateral and angular dechlorination pathways

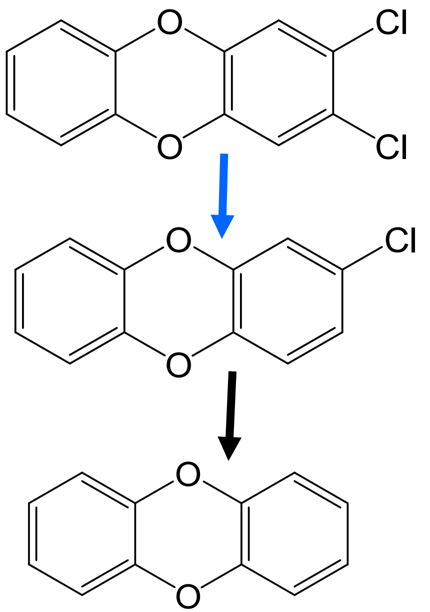
D4 sediment (QT) microcosm

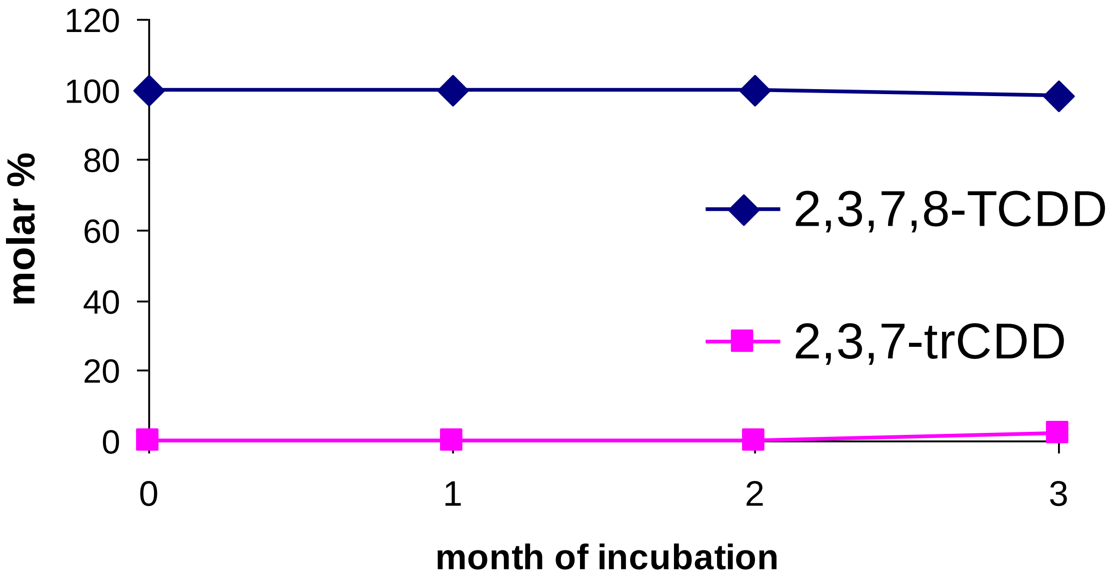


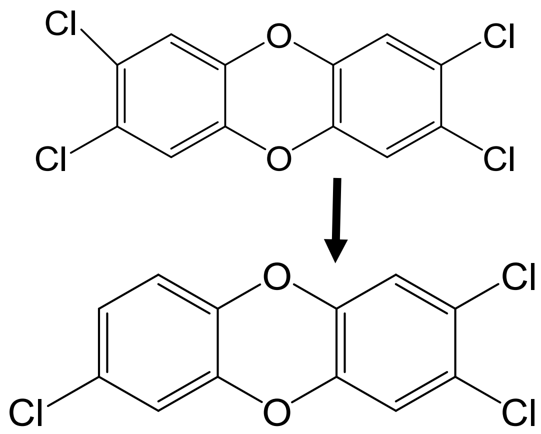


2,3,7,8-TCDD dechlorination by positive 2,3-DCDD dechlorinating community

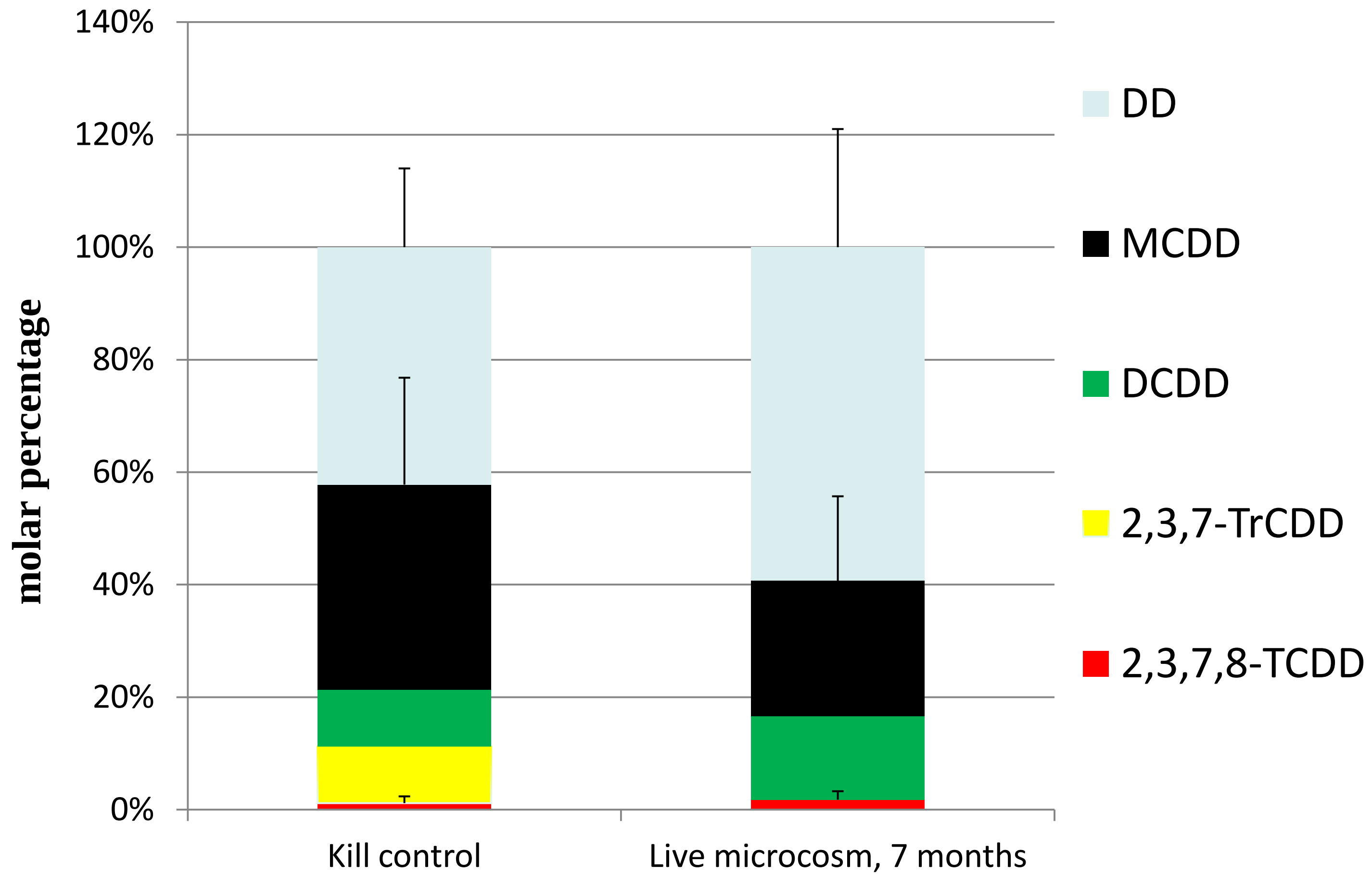








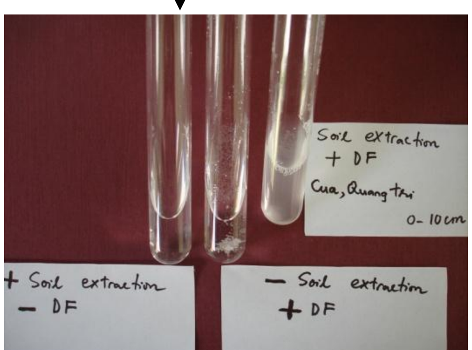
Enhancing dechlorination of PCDDs in Danang sediment by anaerobic incubation



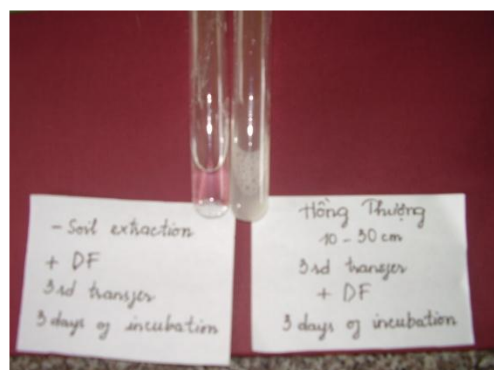
Isolation of Dibenzofuran-degrading aerobic bacteria

Soil/sediment sample

Soil extraction



Several times

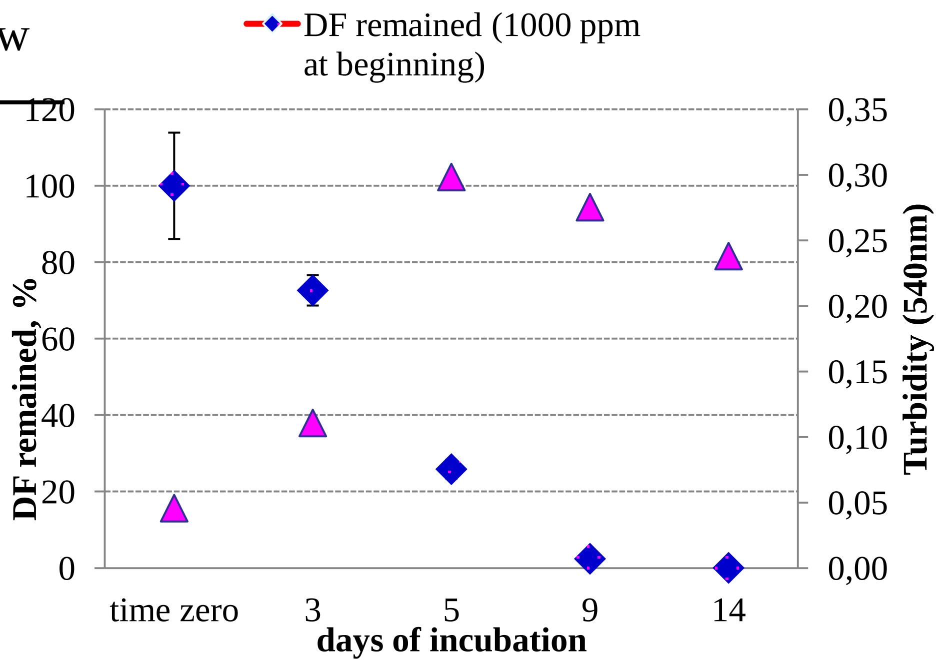


Aerobic dibenzofuran degardation of isolates

Isolating site/19 samples	Time getting turbid in liquid media, days	Media color
Đất lúa HươngLâm (R1)	5	white
Đất rẫy HươngLâm (S7)	5	yellow
Đất sân bay Aso (ĐAS)	20	yellow
Bùn Mai Đàn (BMĐ)	16	yellow
Đất lúa Mai Lộc (ĐML)	14	yellow

R1

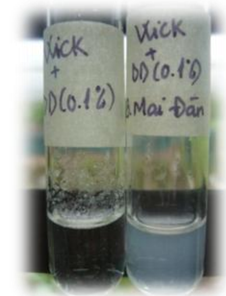
S7

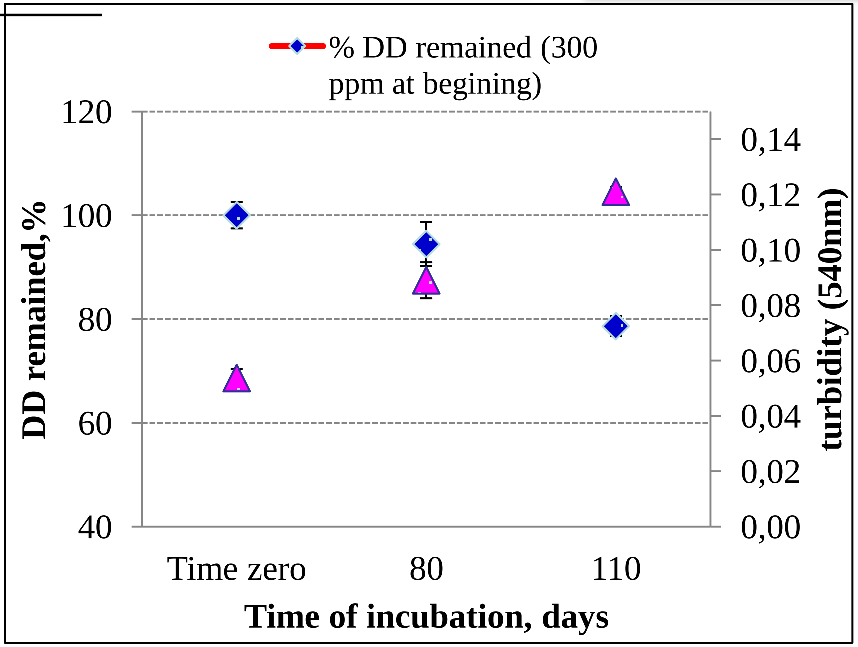


Aerobic dibenzo-*p*-dioxin degardation of isolates

Isolating site/19 samples	Time getting turbid in liquid media, days	Media color
rice field, A Luoi (R1)	60	white
A Luoi (S7)	80	white
Cua, Mai Đàn (BMĐ)	20	white
Aso, stock place (BAS)	30	white
Cua, Mai Lộc (ĐML)	35	white


S7


BMĐ



Conclusions

- After more than 40 years, the residues of dioxins in soils/sediments in some hotpots are still high.
- Both reductively polychlorinated dibenzo-*p*-dioxin (PCDD) - dechlorinating and aerobic Dibenzofuran-degrading bacteria appear to be ubiquitous in soils/sediments after 40-year contamination by spraying with Agent Orange
- Activities of PCDD reductive dechlorination and dibenzofuran degradation in microcosms show a potential of using indigenous bacteria to detoxify dioxins and the need to create appropriate environmental conditions for enhancing microbial detoxification of dioxins.

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Acknowledgements

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