PCBs in the environment :

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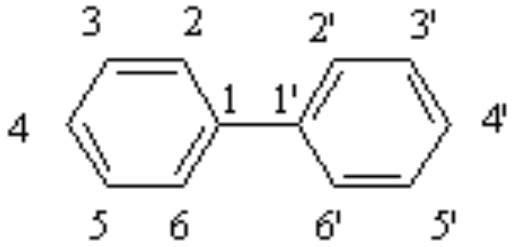
What are PCBs ?

- Mixtures of **P**oly**C**hlorinated **B**iphényls
- Synthetic coumpounds
- Oily liquids or resin, colorless to light yellow
- Inertness, thermal stability, insulating



1 to 10 Hydrogens substituted with Chlorine

A variety of names

- **Trade names**
  - France : **Pyralène** (Prodelec) and Phénochlor
  - USA : **Arochlor** (1248 : 48 % of chlorin w/w, etc.)
- **209** PCB **congener** for 10 « families » of homolog (mono- to déca-)
  - 50 molecules / synthetic mixture
  - Actually : 130-150 molecules (production)
- **Nomenclature BZ** (Ballscchmitter et Zell) modified in 1993
  - Shorthand congener numbering system
  - PCB 1 → PCB 2O9 (linked with IUPAC* system)
- **CASRN**** / congener / homologue / produits
  - More than 200CASR numbers !

* International Union of Pure and Applied Chemistry

**Chemical Abstract Service Registry Number

A large use for a « dream product »

- Total world production : **1-2 millions tonnes** since 1929
  - chlorination of biphenyl with anhydrous chlorine & catalyst
- **Wide scale of applications**

→ closed

- Heat transfer & hydraulic fluids
- Transformers & capacitors

→open-end

- flame retardants, inks, adhesif (mastic), duplicating paper,paints, pesticide extendeur (wood), plasticizers, surface and metal , durface coatings, wire insulator, ..)

that turns into a nightmare…

- **Persistent** : 200 000 tonnes remain in mobile environnemental reservoir (WHO,2003)
- **Traveller & evolutive cocktails**
- **Biomagnification** , greater bioaccumulation in **fatty** tissues
- **Toxic for human health** (and other beings..)

Transport, partitioning, transformation

- **« Congener dependant »**
- More or less absorbed, soluble, volatil depend of **number & position of chlorine**
- Higher chlorinated more likely to sorb, while lower chlorinated more likely to volatilize
- **Dechlorination**
  - **Sédiments et soils = réservoir + secondary source Biodégradation** (aéro & anaérobic)
  - **Water Photolysis** (depth < 0,5 m, sunlight , mono to tetra : half-time 17 → 210 days)
  - **Air :** reaction with hydroxyl radicals photochemically formed), Half-times : 3,5 days (mono)→ 83 d. (penta)

Package tour…

- 0-1 chlorine remain in the atmospher
- 1-4 migrate toward polar latitudes (cycles volatilization/ deposition)
- 4-8 remain in mid-latitudes
- 8-9 remain close to the source of contamination

What we know

- **Enter easily (by every route)**
  - Workers: **Inhalation** (80 %), **dermal** (20%)
  - General population: **Ingestion** food > Inhalation > ingestion water
- Remain in fatty tissues

  (blood lipids, fat, brain, liver, skin,)
- **Cross placenta**
- **Accumulates in breast milk**

How can we know ?

By accumulating evidences about causal relations between exposures & effects

- **Major issue : measurement !**
- **Human studies**
  - **Poisonings**
  - **Workers** **<u>but</u>** Worker Healthy Syndrom products (not environmentla mixtures) with impurities with impurities and other exposures
  - **Fisch eaters**, **breast milk** from fisch eater or workers but co-exposures to POPs, metals such as Hg..)
- **Animal studies**
  - Most of time products tested
  - Bring arguments for a causal link but animals aren't human !

Effects on humans

- **Acute exposure** : almost nothing
- **Long term effects** : epidemiological studies
- « **Oil disease** » : **Yusho** (Japan, 1968, 2000 people) et **Yu-Cheng** (Taïwan, 1979, 2000 people) rice oil contaminated with PCBs (Kanechlor 400 48% chlorine w/w) & polychlorinated quaterphenyls & furanes
  - Dermal, nails, ocular effects (chloracne, pigmentation,..)
  - Liver dammage
  - Neurotocicity & Immunotoxicity even for future children !
  - Decrease birth weight, neurodevelopment toxicity (IQ, memory, ..)
- **Fish eaters** : effects on children via placenta & breast milk (Great lakes, North of Europ, …)
- **Workers**
- Supported by animal and « mecanism of action » studies

Carcinogenic ?

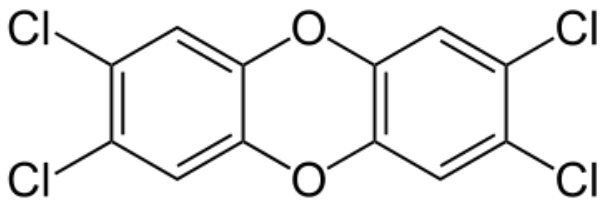
- Limited evidence for carcinogenicity to humans
- **Which cancers ?** Gastrointestinal, **liver, bile ducts, gall bladder, malignant melanoma**, not conclusive for breast cancer (but sensitive sub population?)
- Sufficient evidence for carcinogenicity to animals (liever, intestinal, stomach)
- IARC (1987) : groupe **2A probably carcinogenic to humans**
- EPA (2000) : Classification **B2** probable human carcinogen

So …. Yes ! **and more..**

Effects **oestrogenic & anti-oestrogenic, thyroid**

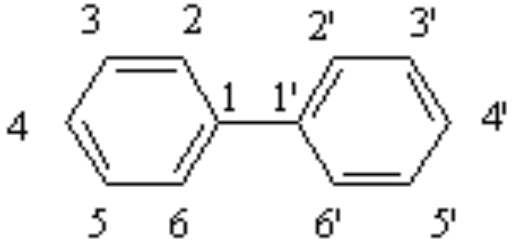
Don't forget **neurodevelopment & immunotoxicity !**

What does « Dioxin Like » mean ?



Seveso Dioxin

2,3,7,8-tétrachlorodibenzo-p-dioxine



PCB
Position Cl

2,6 : ortho

4 para, 3 et 5 meta

Coplanar :"credit card"

Non ortho, mono-ortho

Coplanar => binding to the Ah receptor one of the modes of action
=> Toxic Equivalence Factor (TEF) / Seveso Dioxin

- **7 PCBi** : 28, 52 ,101 ,118 (DL) ,138 ,153 et 180)
- **12 PCB « dioxin like »** (DL) WHO

77; 81;**126**;**169**;105;114;118;123;156;157;167;189

(FET 126 : 0,1 & FET 169 : 0,03)

Chronic MRL Seveso dioxin = 1**p**g/kg.d !!

- **WHO :** Tolerable Daily Intake (20 **n**g/kg.j)
  Arochlor 1254 (US-EPA et ATSDR idem)

+ ou - ITEQ (International-Toxic Equivalent Quantity)

- **RIVM** : TDI for "7 indicators" (50 % Arochlor)
- **ATSDR** : TDI "PCB" (cocktail // breast milk)
- **US-EPA** : Slope Factors for *high / low / lowest risk & persistence"*

Key messages

- Exposure mixtures aren't product mixtures
- Enter easily human being even before birth
- Alter neurodevelopment and immune system, endocrine disruptor
- Susceptible population : future mother and children +++
- Probably carcinogenic to humans