Ecotoxicology & Ecological Risk Assessment (WB.INS-38)

- *Contents of the course and organizational matters*
- *History of ecotoxicology – great ecological disasters*
- *Nutrients and xenobiotics*

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Lectures – discussion classes:
Monday, 11:30 - 13:20 (13 x 90 min = 26 class hours)

- Chemical elements and compounds in the environment; which can be toxic and why?
- Toxicodynamics – effects of chemicals on organisms, mechanisms of action
- Effect of environmental factors on toxicity
- Defense mechanisms in organims
- ECOtoxicology – ecological paramterers in the toxic effects assessment (populations, communities, ecosystems, genetic pool)
- Studying toxicity: ecotoxicological tests, experimental designs, data analysis
- Toxicity and extinctions – interactions between toxicants and stochastic factors
- Ecological Risk Assessment

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Practicals

- dr hab. Beata Klimek
- Thursday, 11:30 – 14:00 (room 2.0.7)
- 14 lecture hours (7 x 90 min)
  - Exact plan of the practicals will be given by dr Klimek

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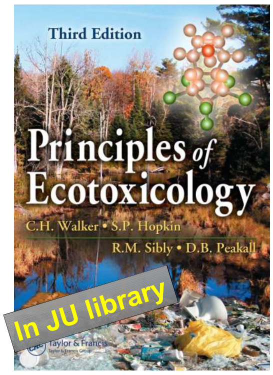
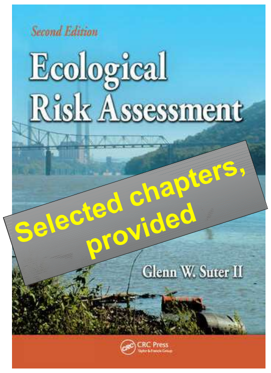
Course handbooks



In JU library



Selected chapters, provided

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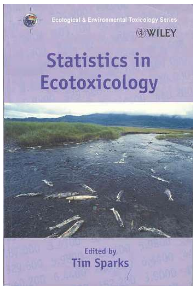
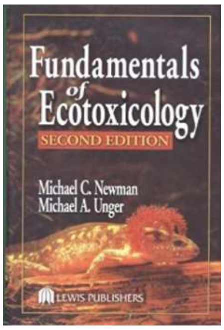
Supplementary handbooks



Or any general
hanbook on statistics



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Ecotoxicology – what exactly it is?

- "Examines chemical substances occurring in the environment in terms of their impact on living organisms in a long-term, systematic and low-dose manner" (Rejmer, 1997)
- Deals with the protection of ecological systems against the harmful effects of synthetic chemicals" (Calow, 1993)
- "Studies harmful effects of chemicals on ecosystems" (Walker i in., 1996)
- "The science that integrates the ecological and toxicological effects of chemical pollutants with the fate of these pollutants in the environment (movement, transformation, decomposition)" (Forbes i Forbes, 1994)

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Defining the field

- "**Science** is about creating an intellectual model of the material world. **Technology** deals with procedures and tools and their general application to the acquisition or application of knowledge. **Practice** focuses on solving individual cases. Mixing these three concepts can be dangerous" (Slobodkin i Dykhuizen, 1991)
- ***Ecotoxicology is the study of the effects of toxic substances on living organisms and the consequences of these interactions manifested at levels of organization higher than a single organism***

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Prehistory ☺

- "*What's too much, it's unhealthy*" Polish proverb
- "***Sola dosis fecit venenum***" – Paracelsus (Phillippus Aureolus Teophrastus Bombastus von Hohenheim; 1493-1541)
- **Shelford's law** of tolerance (Victor E. Shelford; 1877-1968)

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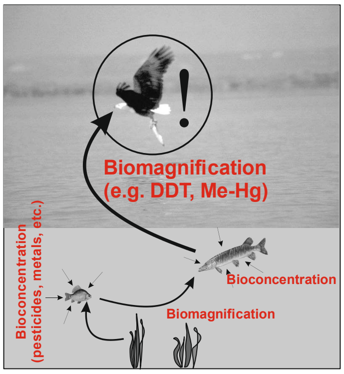
It all started with that:



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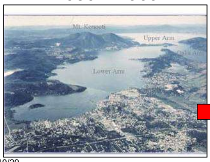
- bioconcentration
- biomagnification

→ **mass extinction of birds of prey**

Clear Lake (California)
1950 – 1960



DDT exterminate Sciaridae flies

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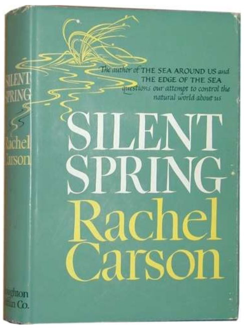
Rachel Carson – „Silent spring" (1962)



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Other famous ecotoxicological disasters

- **Minamata disease**: 1950s., Japan - Chisso Corporation → **Hg** → Minamata Bay → fish → humans → ca. 1000 deaths!
- **Itai-Itai disease**: 1920 – 1960, Japan, Toyama Prefecture → rice fields watered with the mine water contaminated with **Cd** → **Cd** in rice → humans → severe bone pain and kidney dysfunction

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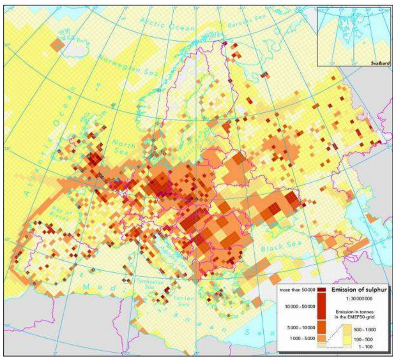
Sulphur emissions in Europe (1995)



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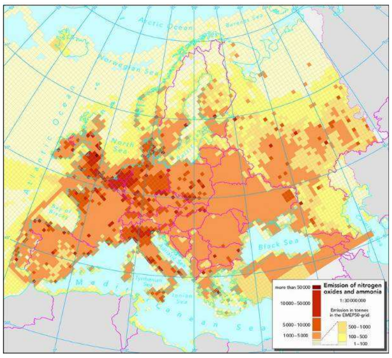
Nitrogen emissions in Europe (1995)



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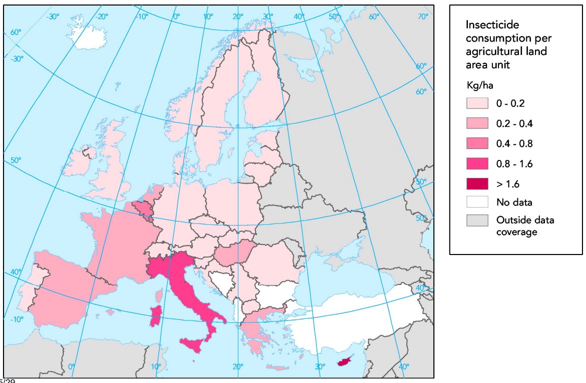
Pesticide use in Europe



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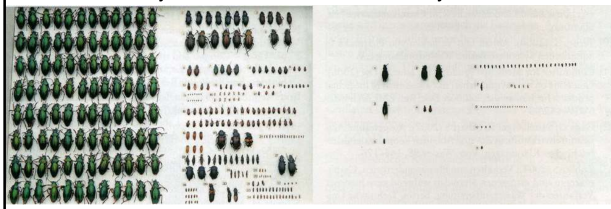
Change in the number of beetles in the winter wheat field in Kiel during 30 years

1st July 1951 | 1st July 1981



All species and individuals caught in 1 trap in 4 weeks

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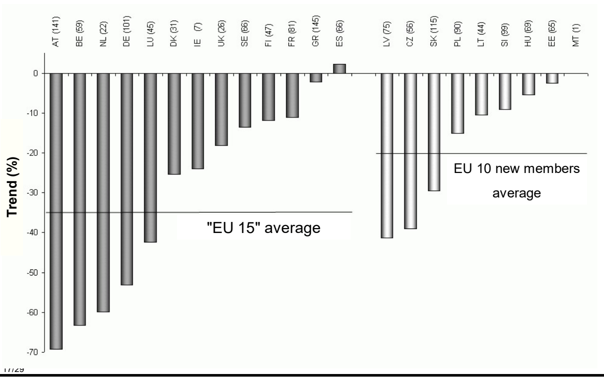
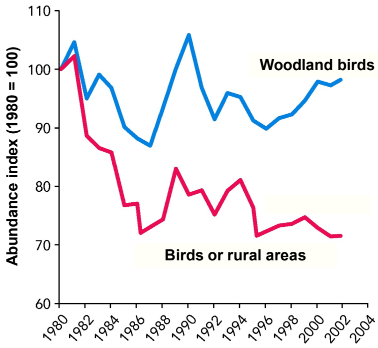
Change in butterfly numbers 1973/74 – 1997/98



Change in bird numbers 1980 – 2002



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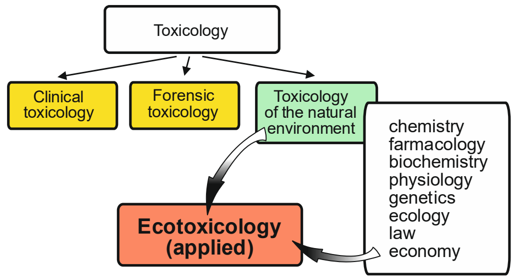
The birth of ecotoxicology



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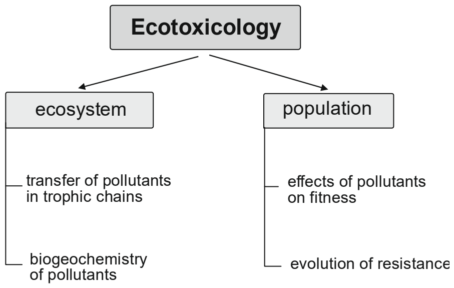
Main branches and problems



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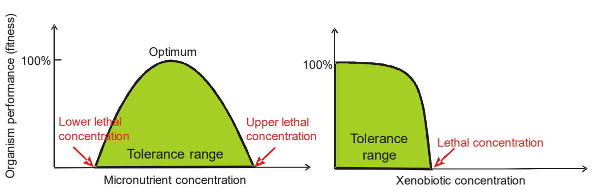
Nutrients and xenobiotics



- **Each organism has its own tolerance range for every environmental factor**
- **Indispensable factors, such as essential nutrients, have specific lower and upper limit values between which an organism can survive**
- **Other factors, e.g. xenobiotics, can be harmless at low values (conentrations in case of chemicals) but become lethal (toxic) above the upper tolerance limit**

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Chemical elements: grouping based on concentration in ocean water

- Major elements (%): **C, O, N, H**
- Minor elements (mg/dm^3): **S, P, Cl, Ca, Mg, Na, K**
- Trace elements (<10^{-3} mg/dm^3): **Sr, B, Si, F, Li, Al, Fe, P, Ba, I, Mo, Zn, Mn, V, Ni, Cu, Co, Sn, Se, Cr, Pb, Cd, Hg, Os, Rb, Ar, In, Ti, U, actinides**

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Nutrients and xenobiotics

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIII	VIII	VIII	IB	IIB	IIIB	IVB	VB	VIB	VIIB	0
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	*As*	Se	*Br*	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	*Sn*	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Ru
Fr	Ra	Ac	Th	Pa	U												

H - macroelements (indispensable in large amounts)
V - microelements (indispensable in minute amounts)
As - microelements probably used by some organisms

In human body 99.9% atoms – 11 most common elements:
- **99% – C, O, H, N**
- **0.9% – Na, K, Ca, Mg, P, S, Cl**

0.1% – remaining ca. 10 essential elements

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What for the organisms use chemical elements – example functions

- C, H, O, N, P, S, Si, Ca, Mg, B, Fe, Zn: construction elements for tissues and membranes; skeleton, teeth, shells
- H, Na, K, Cl, Mg, Ca, P: transmission of neural signals, production of metabolic energy
- Ca, Mg, P: muscle contraction, transport across membranes
- Zn, Ni, Fe, Mn: acid catalysis (related to enzymes)
- Fe, Cu, Mn, Mo, Se, Co, Ni, V: catalysis of redox reactions (related to enzymes)

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Metals - classifications

- Chemical:
  - Class A: oxygen bounding (e.g. Ca, Mg, Mn)
  - Klasa B: S or N bounding (e.g. Cd, Cu, Hg)
  - Transitional (e.g. Zn, Pb, Fe, Co)
- Biological:
  - **microelements (np. Zn, Cu, Ni, Cr)**
  - **xenobiotics (np. Pb, Hg, Cd*)**

* can be utilized by some organisms

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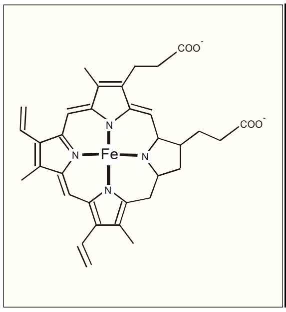
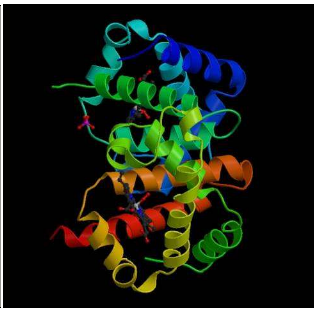
Hemoglobin as an example of the use of a metal in the body





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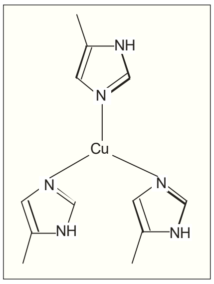
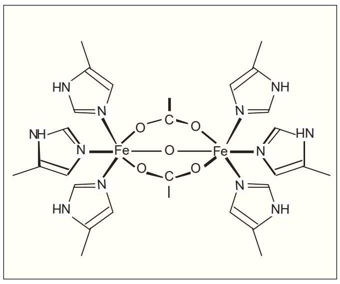
Other Oxygen carriers containg metals (metalloproteins)



Deoxyhemocyanin



Deoxyhemerythrin

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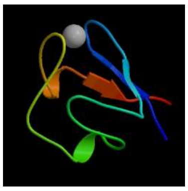
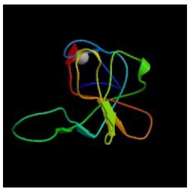
Examples of metalloenzymes



Rubredoxin (Fe):

electron transport



MSS4 (Zn):

conduction of signals via GTPase

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Number of enzymes with individual metals as cofactors

Ca:	27	Mo:	14
Cd:	1	Ni:	5
Co:	13	K:	4
Cu:	20	Na:	1
Fe:	92	W:	2
Mg:	17	Zn:	107
Mn:	39	V:	1

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