Půdní organická hmota, půdní organismy, koloběh uhlíku a zemědělské využití krajiny

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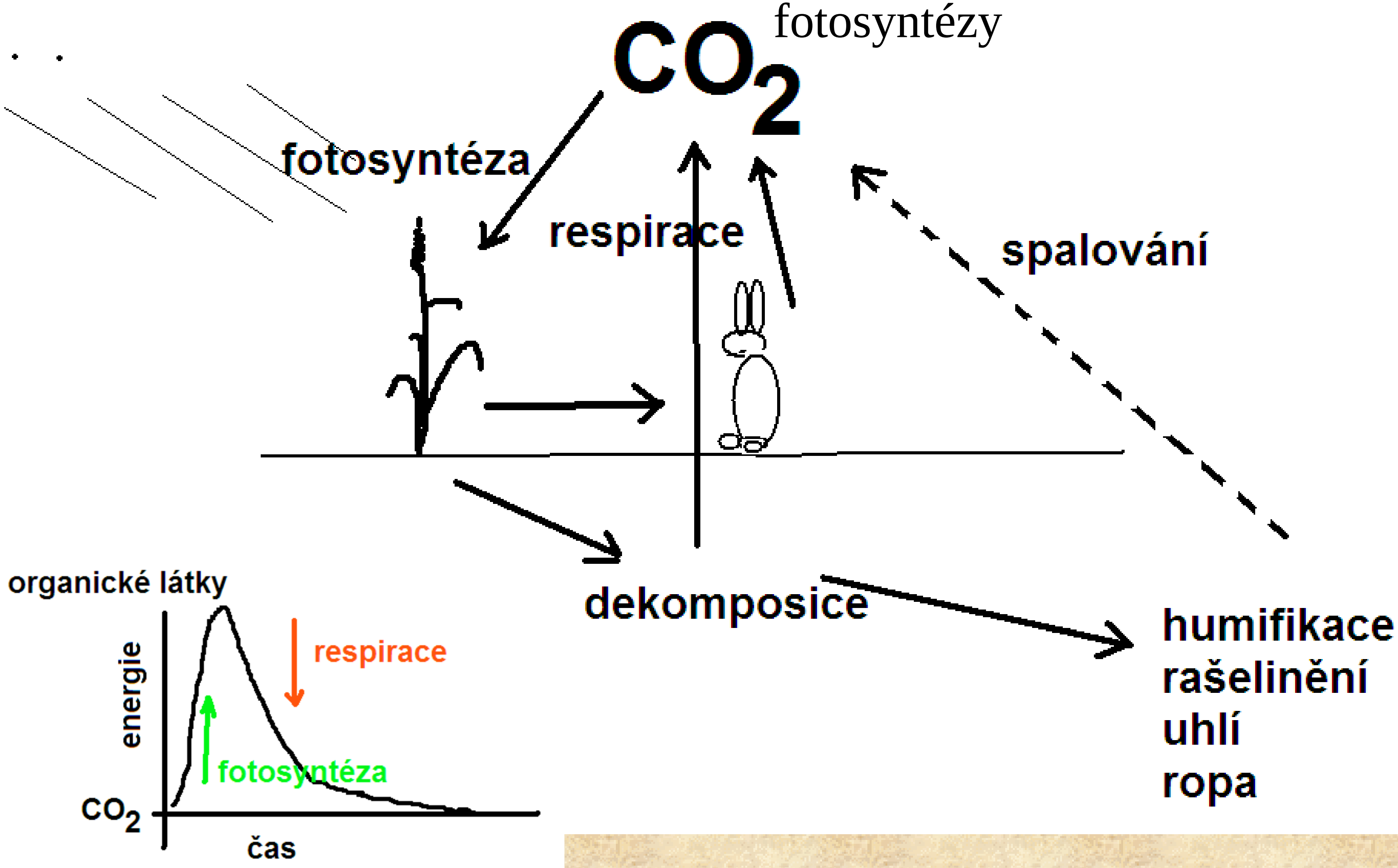
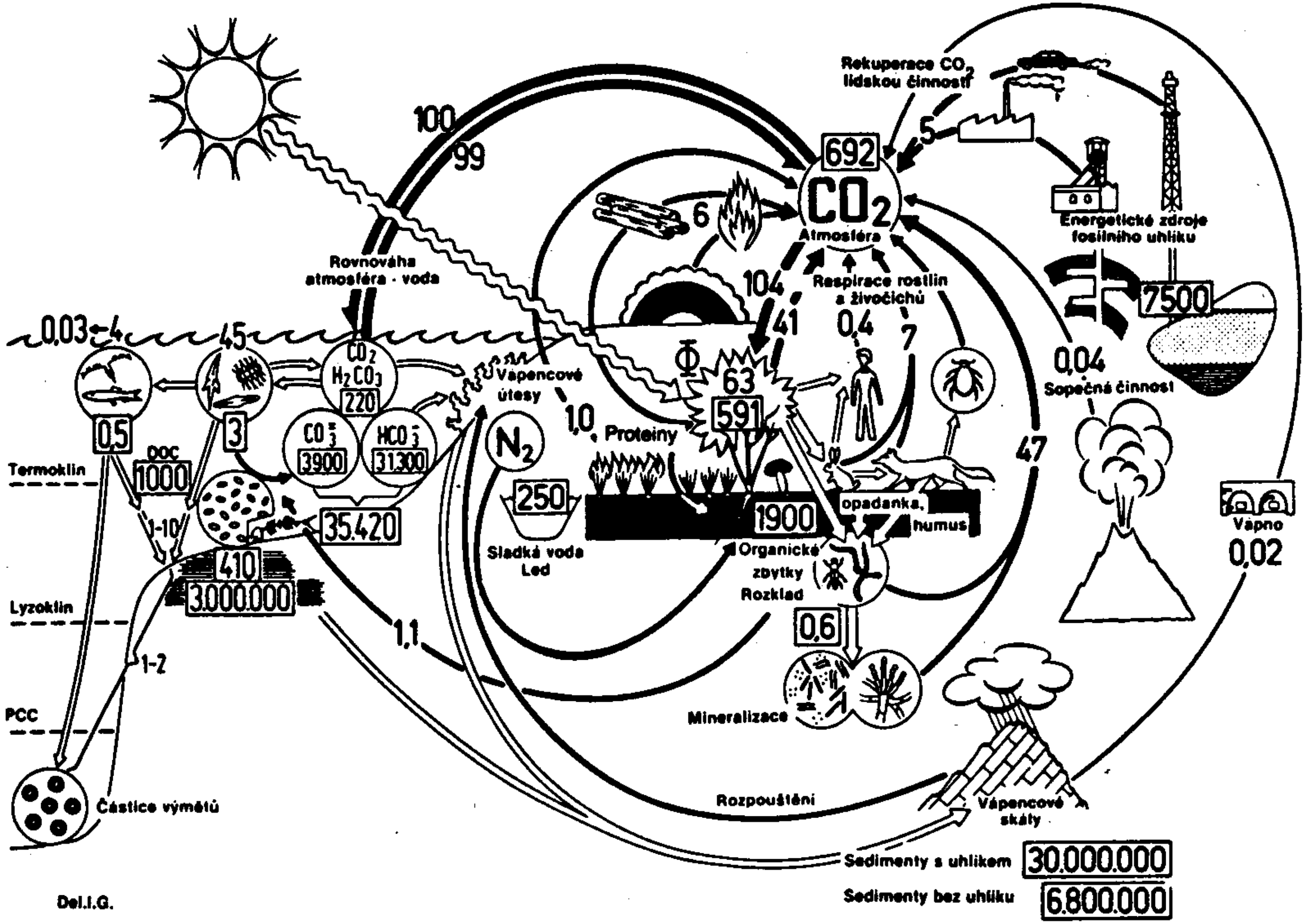
Koloběh uhlíku

Tok uhlíku úzce souvisí s tokem energie, praktiky všechna energie v potravní síti pochází z fotosyntézy



Koloběh uhlíku



Emisní povolenky ČR
86,8 milionu tun CO_2 ročně
23,5 mil t C

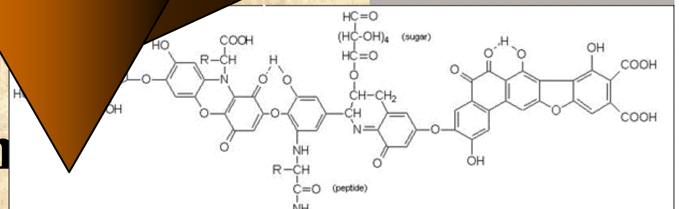
4,7 mil ha zemědělské půdy
změna obsahu C o 0.1%
1m^2 půdy do 30 cm váží 400kg
0.1% je 0.4kg t.j. 4t/ha
2.574 x 4=
10 mil t C

Co je to půdní organická hmota ?

Opad
(raw OM)

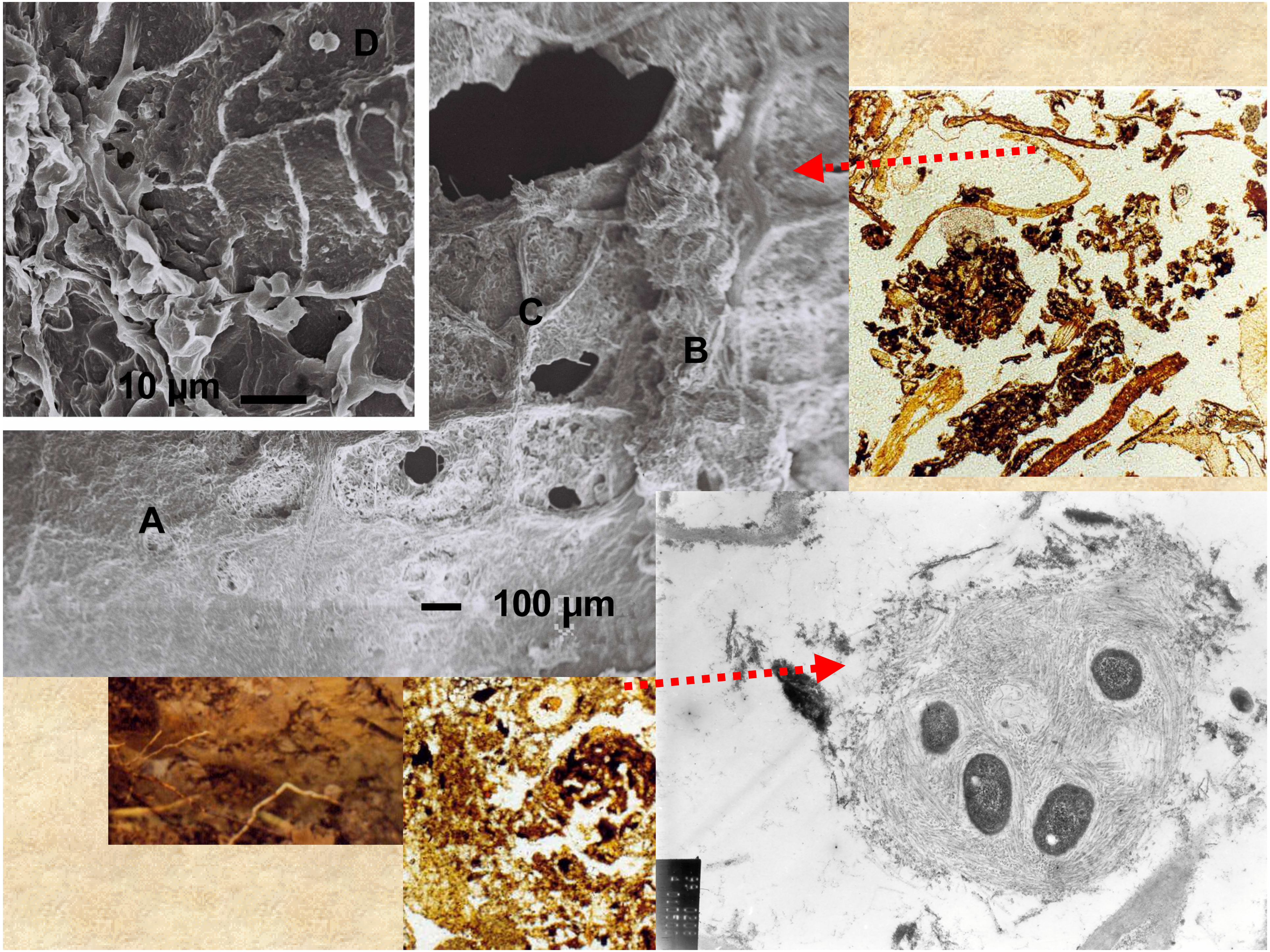
(prodn…
POC, …

…si…M, humus)

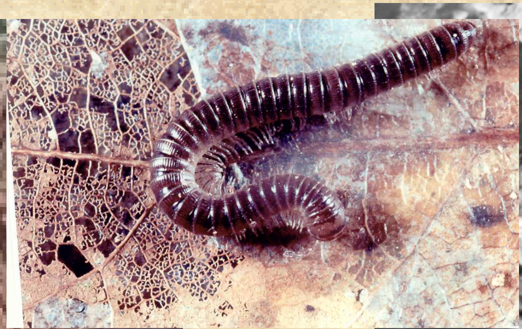


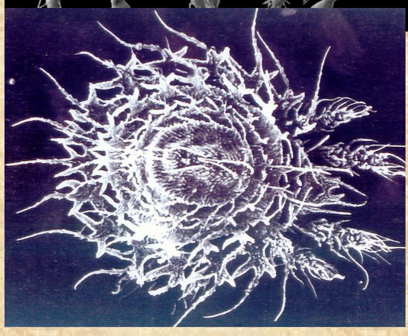
Model structure of humic acid (Stevenson 1982)

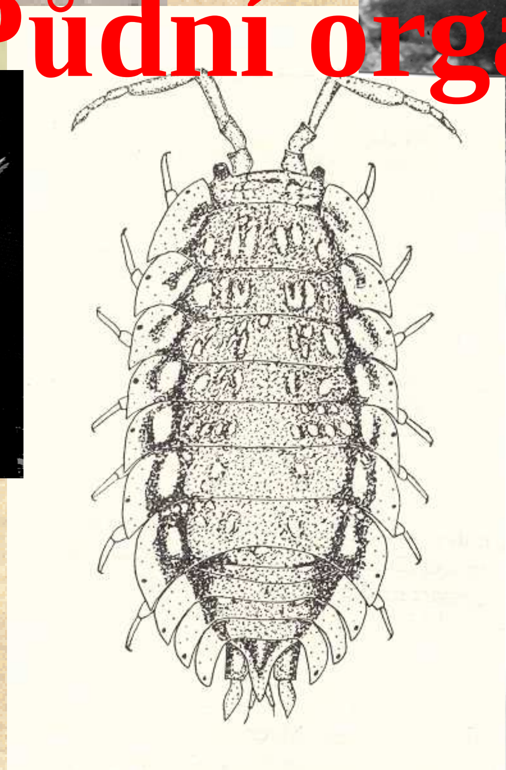
Fossil OM coal, kerogen

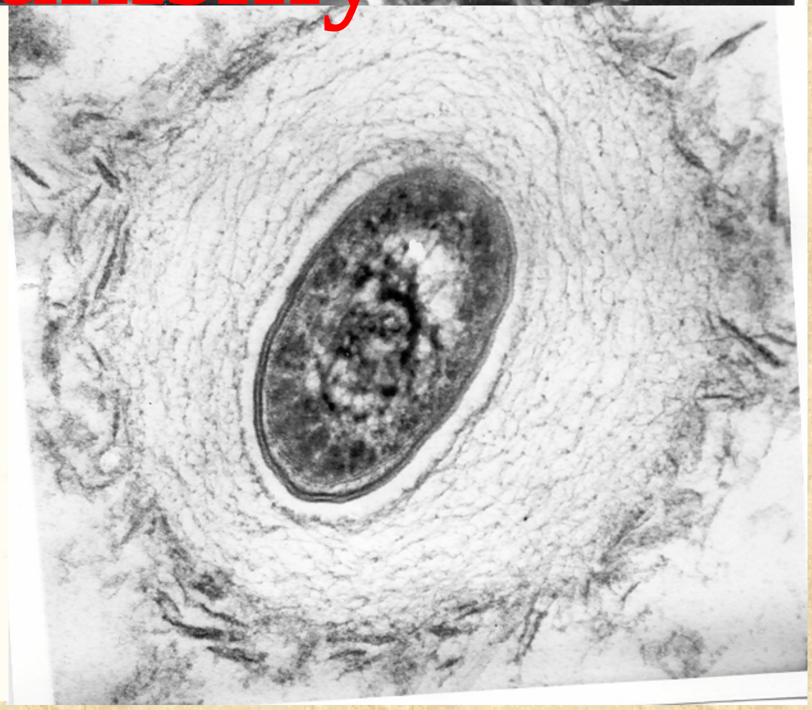

D
C
B
10 µm
A
100 µm

Půdní organismy









Diversita půdních organismů

skupina	počet druhů
Mikroskop. houby	25
Řasy	49
Krytenky	20
Hlístice	43 rodů
Pancířníci	16
Stonožky	7
Mnohonožky	7
Žížaly	3

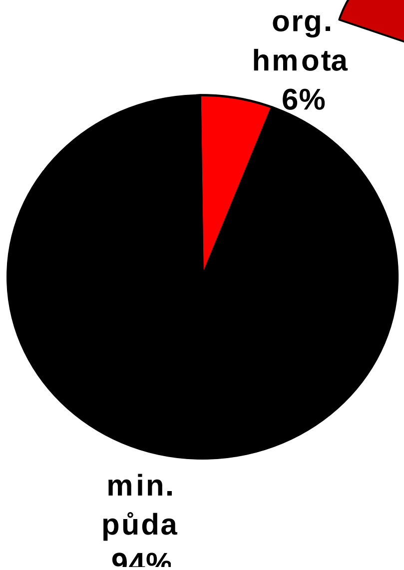
min 170 druhů půdních organismů realisticky i 2x tolik vzorkovaná plocha několik m^2

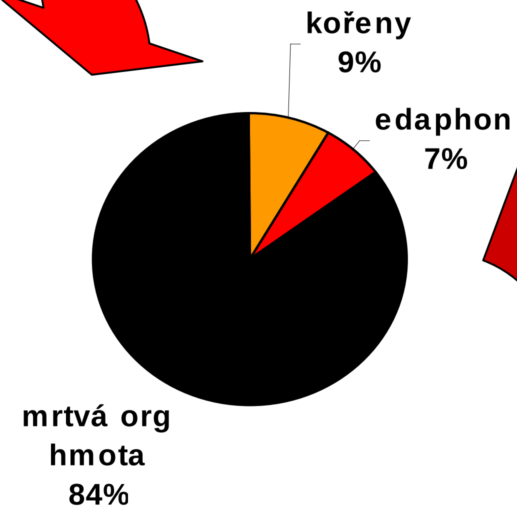
40 let stará výsypka spontánně zarostlá

43 druhů rostlin plocha 10x10m

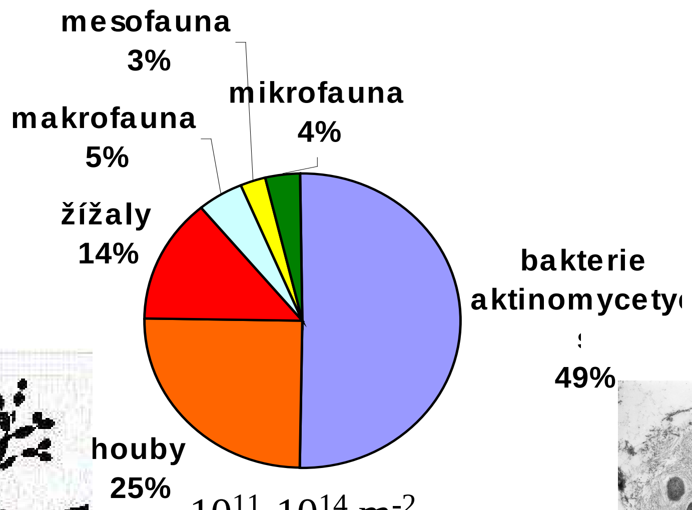
ÚPB kolektiv autorů

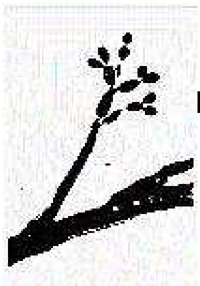
Hmotnostní zastoupení organické hmoty a organismů v půdě



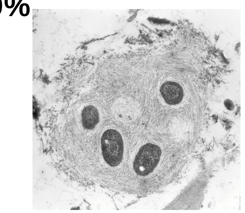


10^{2} m^{-2}
30 g m^{-2}



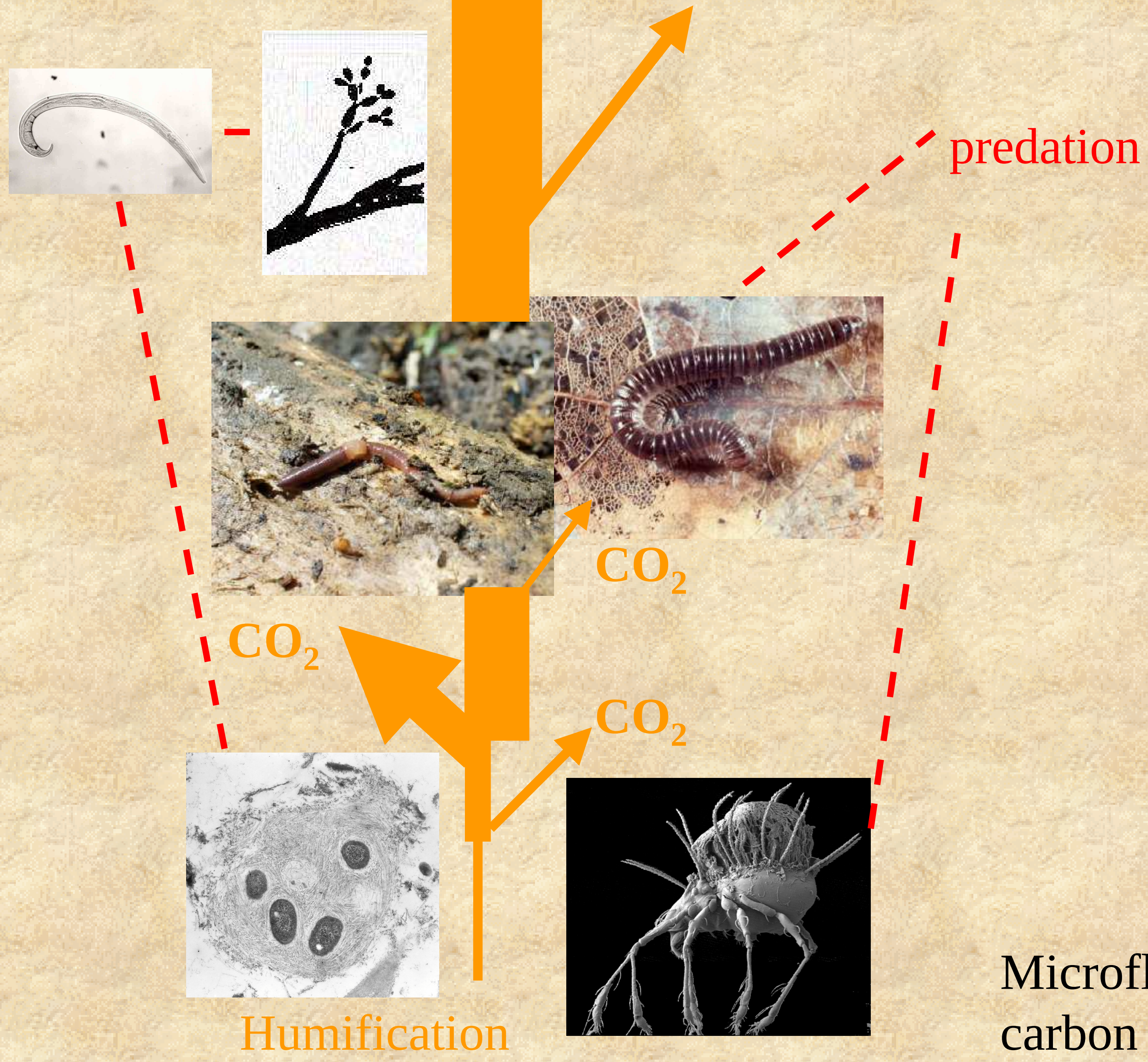


10^{11}-10^{14} m^{-2}
100 g m^{-2}



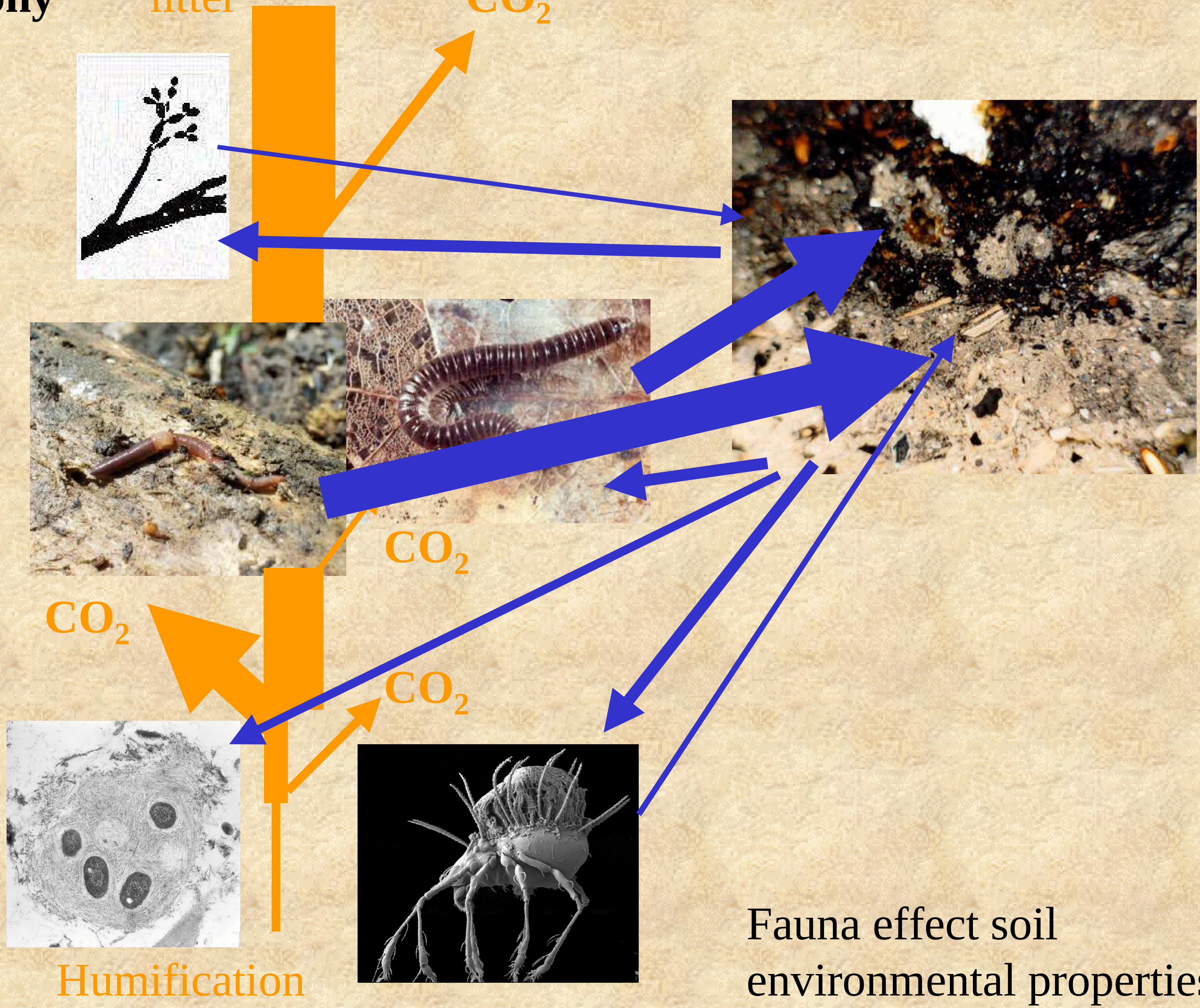
10^{13}-10^{16} m^{-2}
200 g m^{-2}

Philosophy

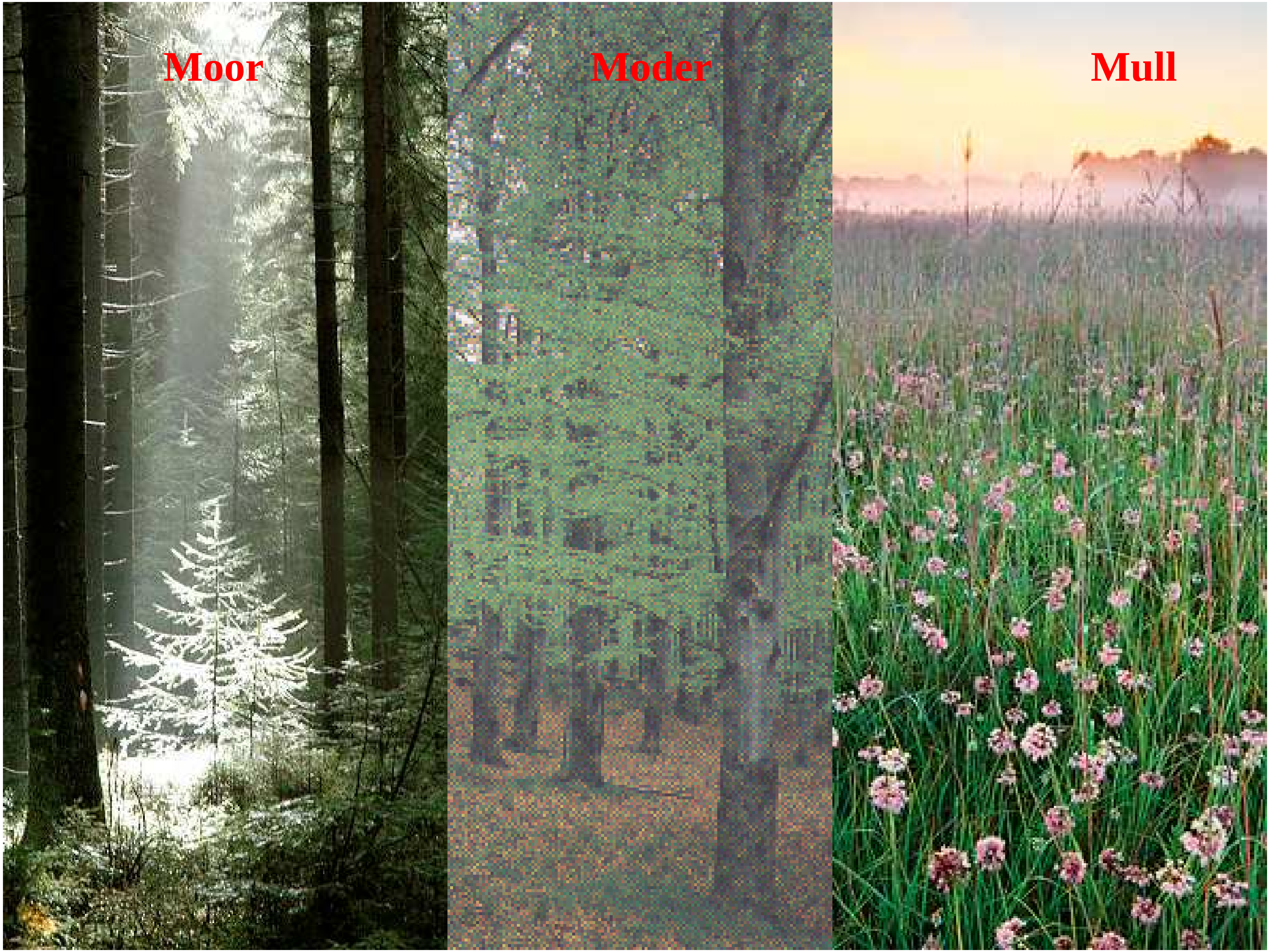


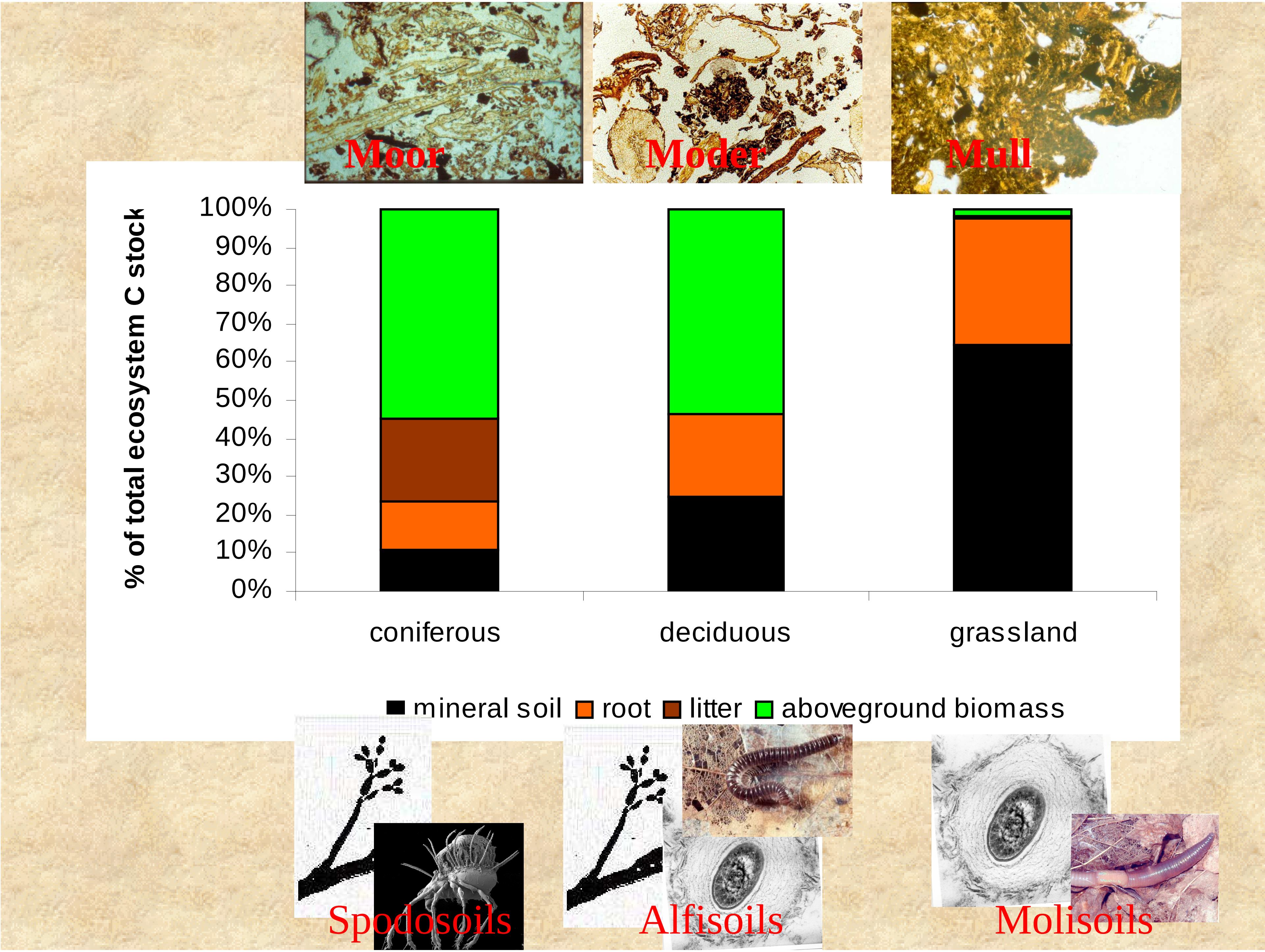
Microflora affect
carbon mineralisation

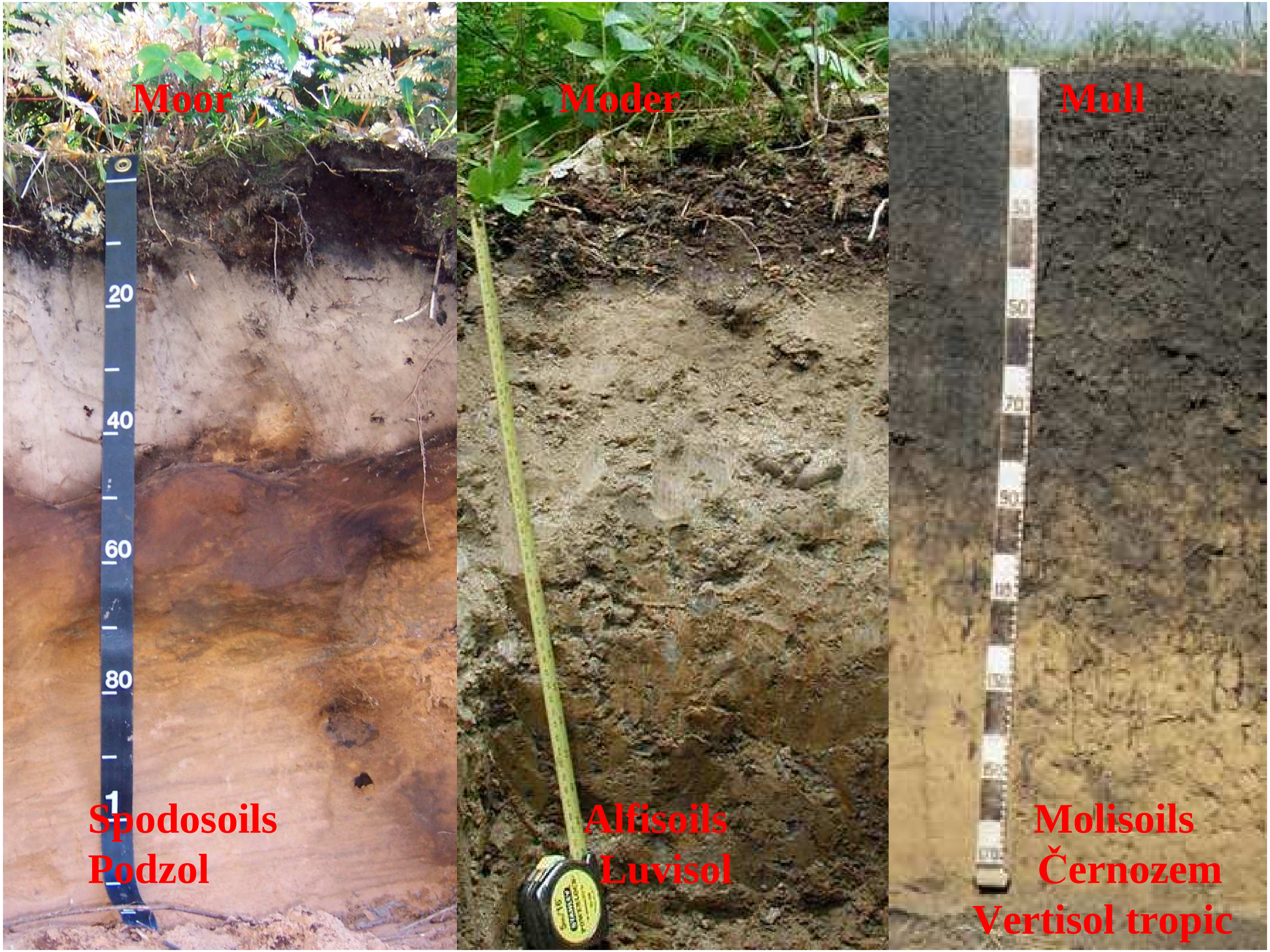
Philosophy

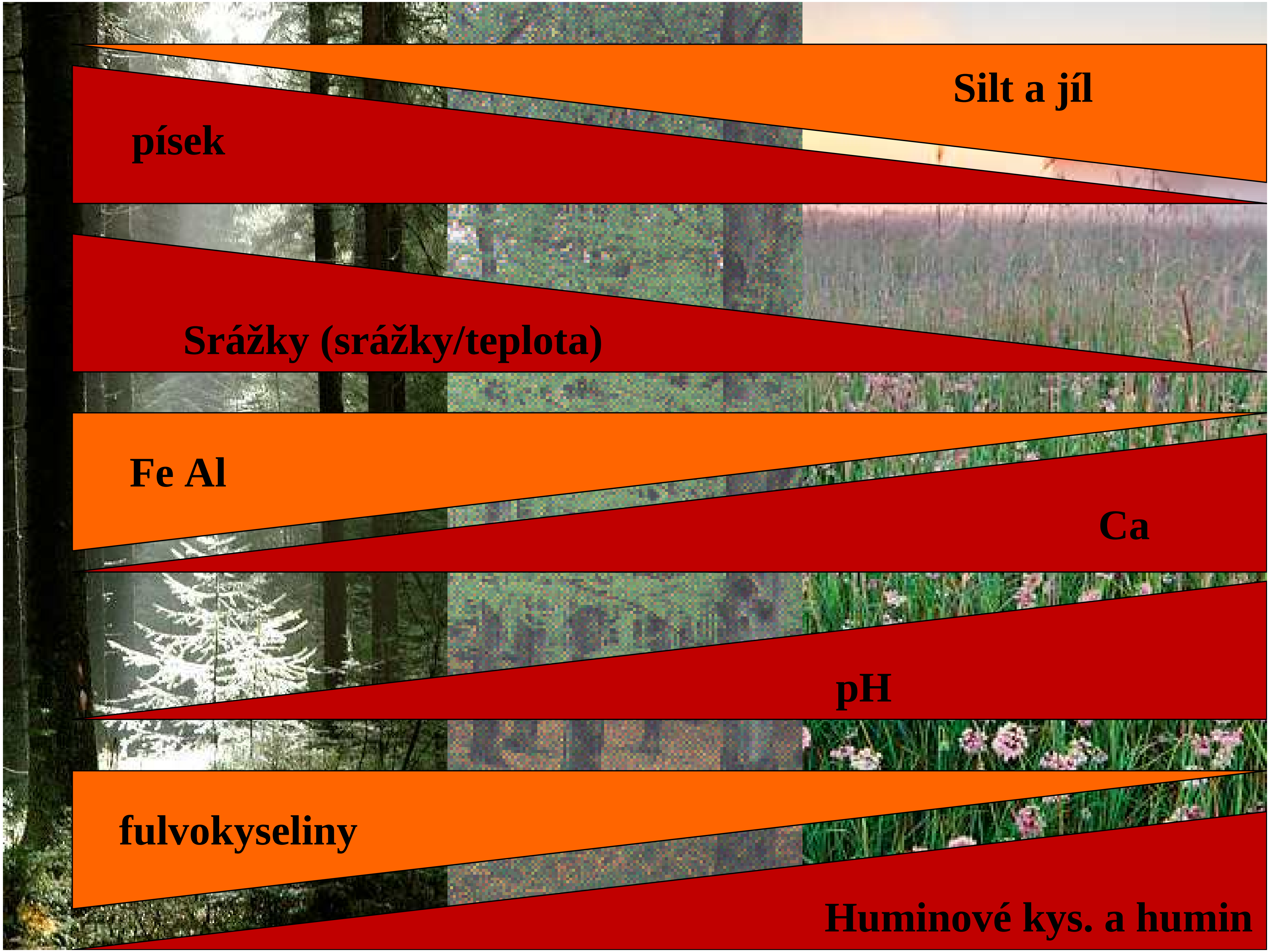


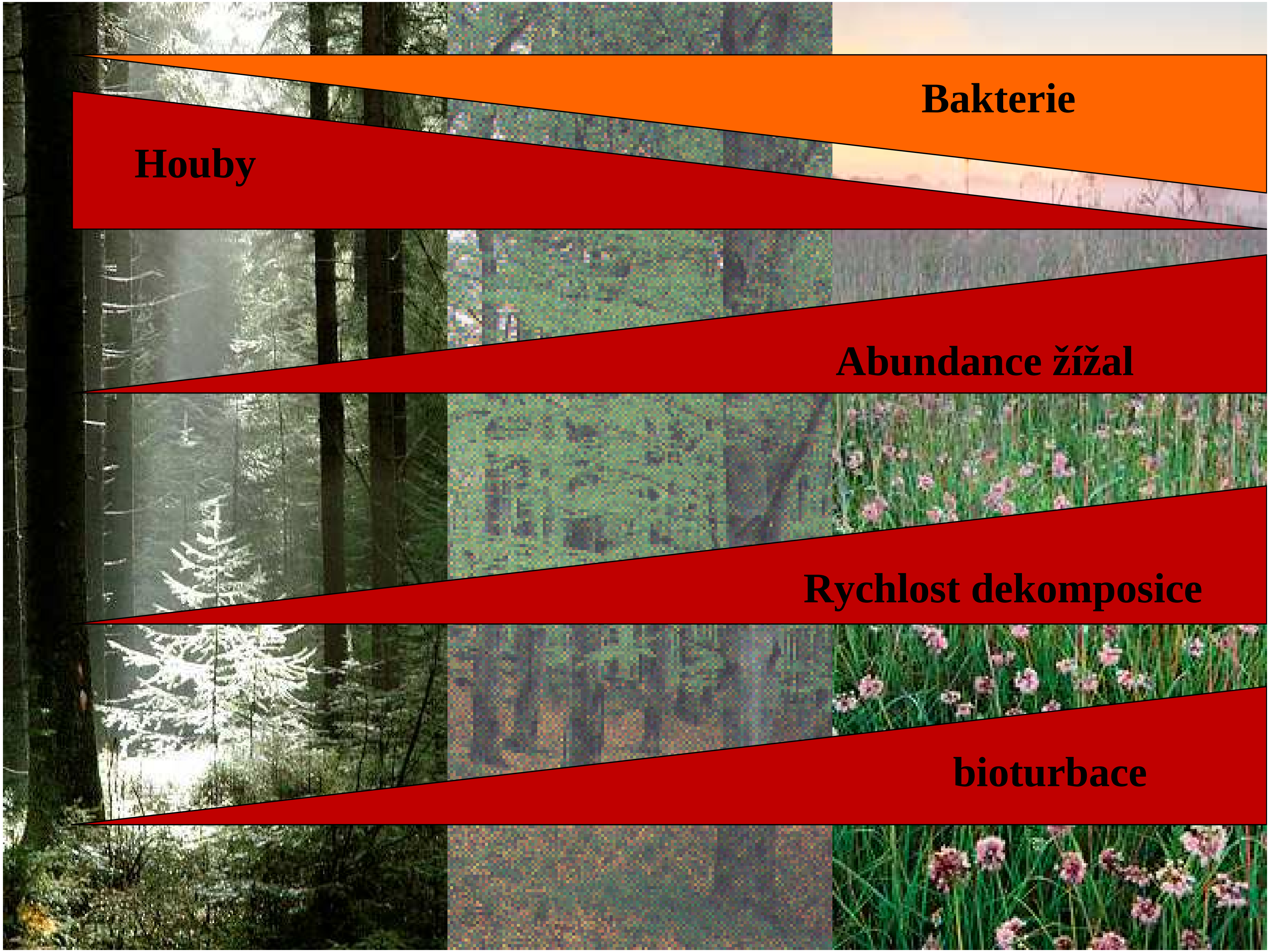
Fauna effect soil environmental properties

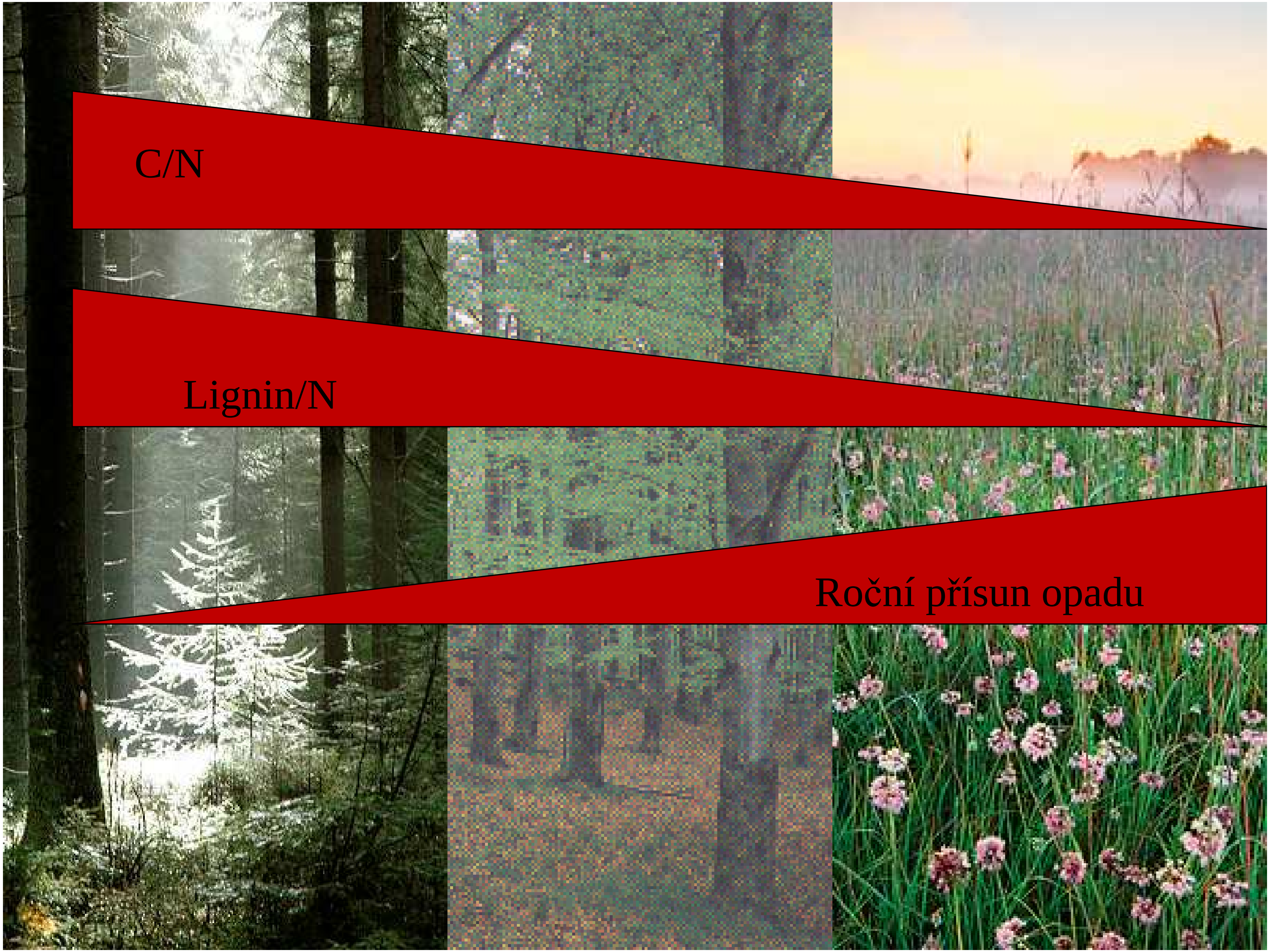

Moor
Moder
Mull


Moor
Moder
Mull
% of total ecosystem C stock
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
coniferous
deciduous
grassland
mineral soil
root
litter
aboveground biomass
Spodosoils
Alfisoils
Molisoils


Moor
Moder
Mull
Spodosoils
Podzol
Alfisoils
Luvisol
Molisoils
Černozem
Vertisol tropic


Silt a jíl
písek
Srážky (srážky/teplota)
Fe Al
Ca
pH
fulvokyseliny
Huminové kys. a humin


Bakterie
Houby
Abundance žížal
Rychlost dekomposice
bioturbace


C/N
Lignin/N
Roční přísun opadu

Geologický substrát

Klima

Vlastnosti substrátu

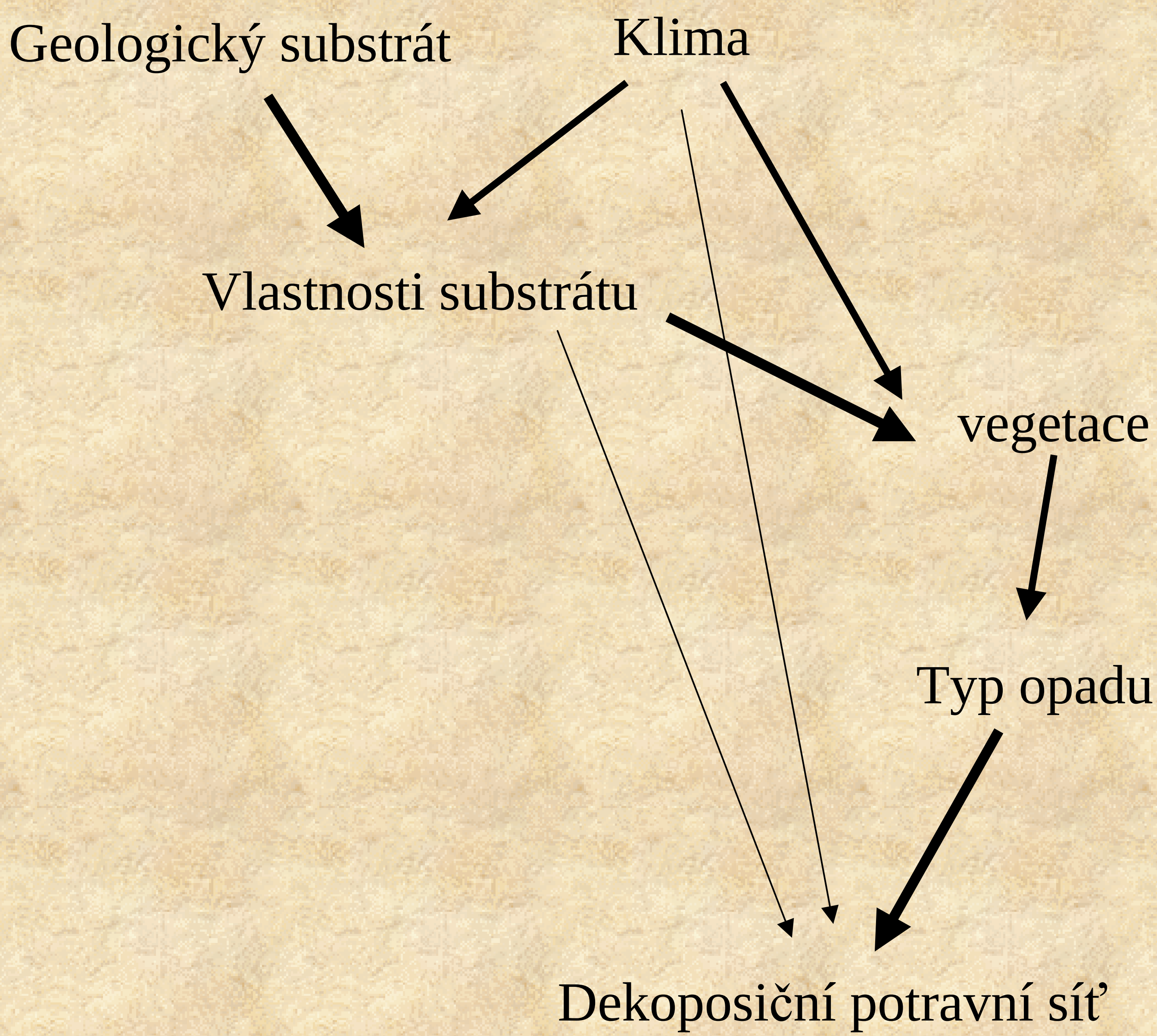
Geologický substrát

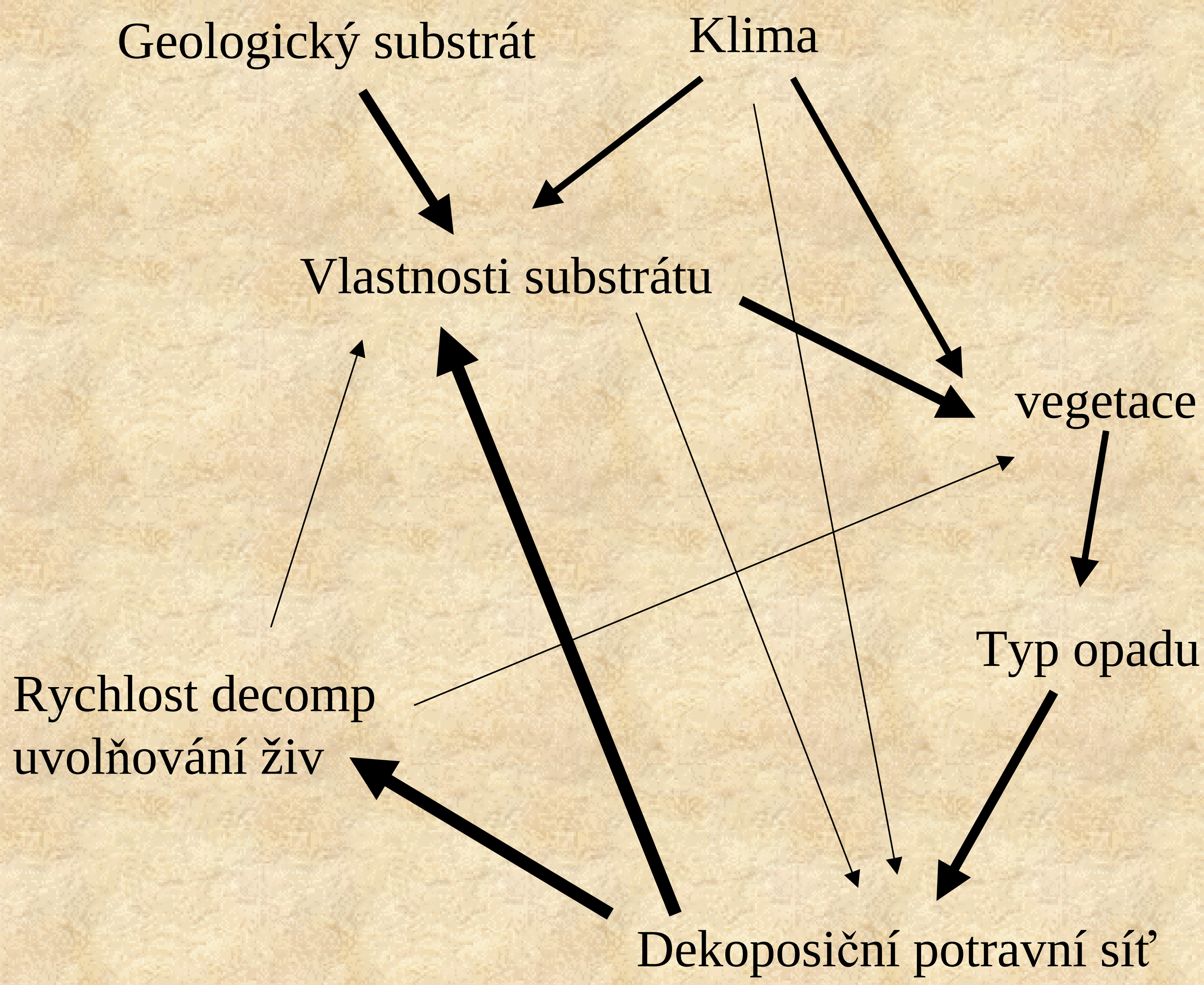
Klima

Vlastnosti substrátu

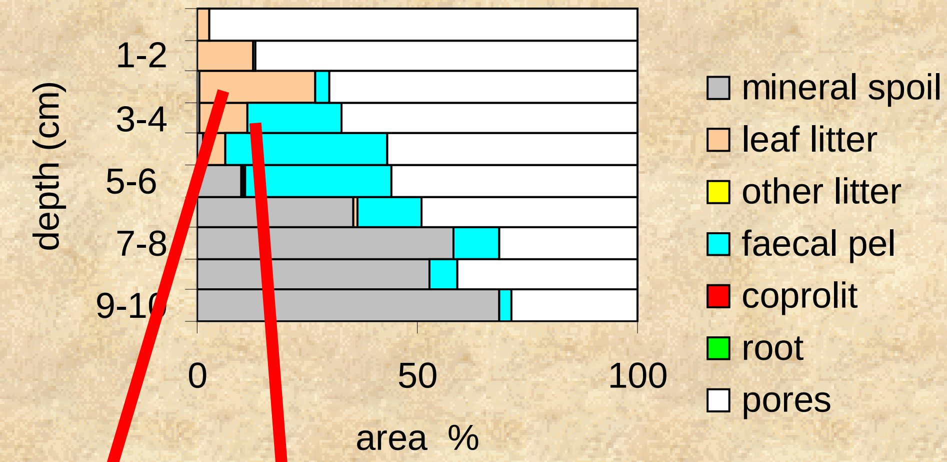
vegetace

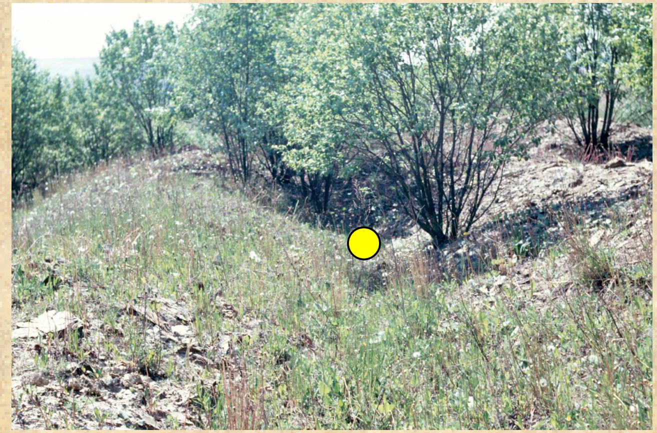
Typ opadu

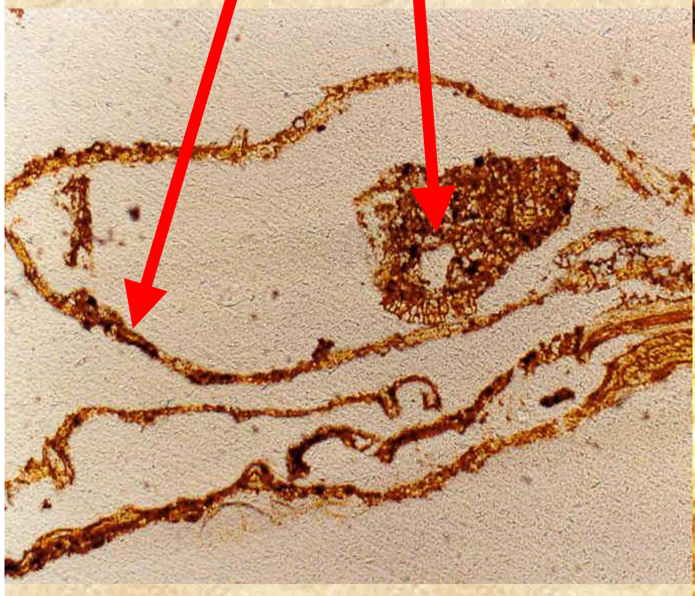

Geologický substrát
Klima
Vlastnosti substrátu
vegetace
Typ opadu
Dekoposiční potravní síť

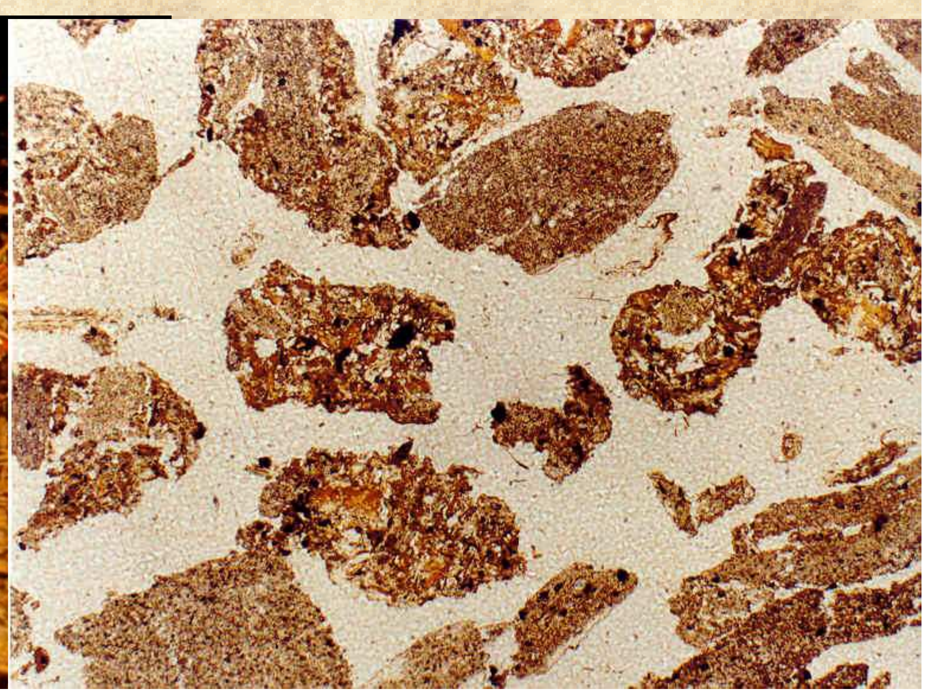

Geologický substrát
Klima
Vlastnosti substrátu
vegetace
Typ opadu
Rychlost decomp
uvolňování živ
Dekoposiční potravní síť

Spontaneous succession - 23 years old plot

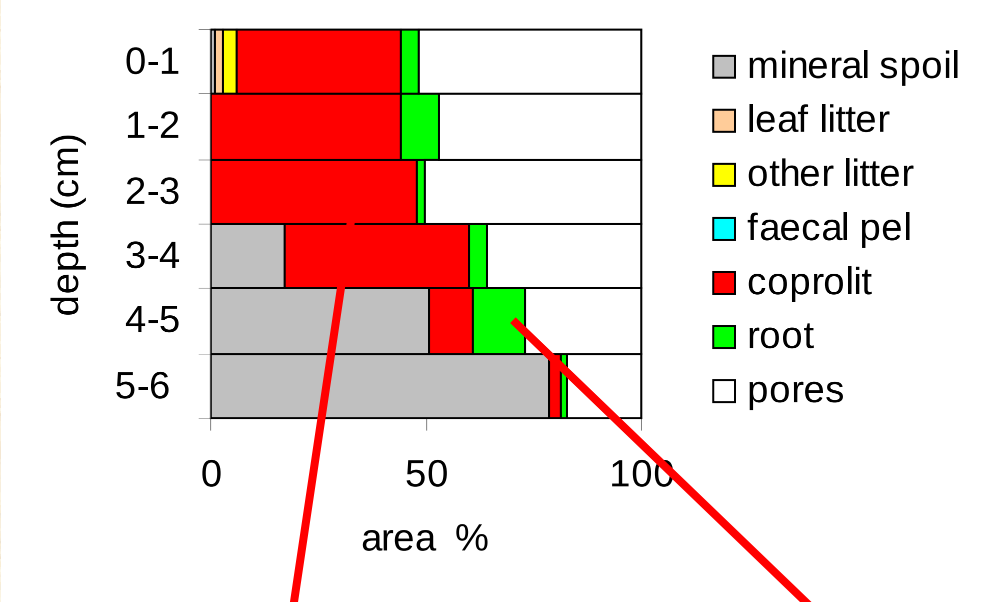


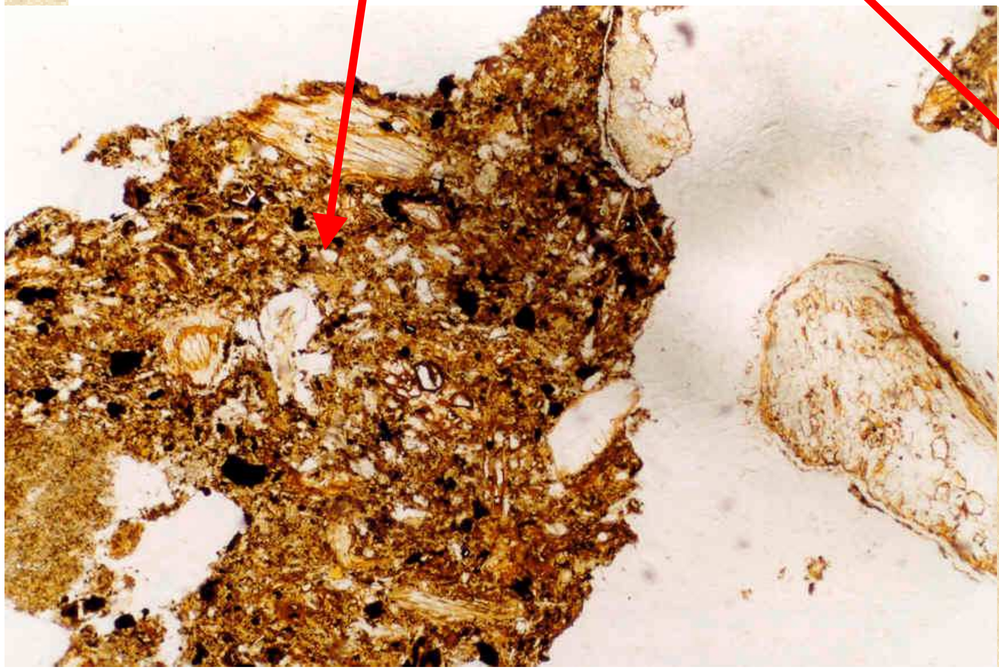


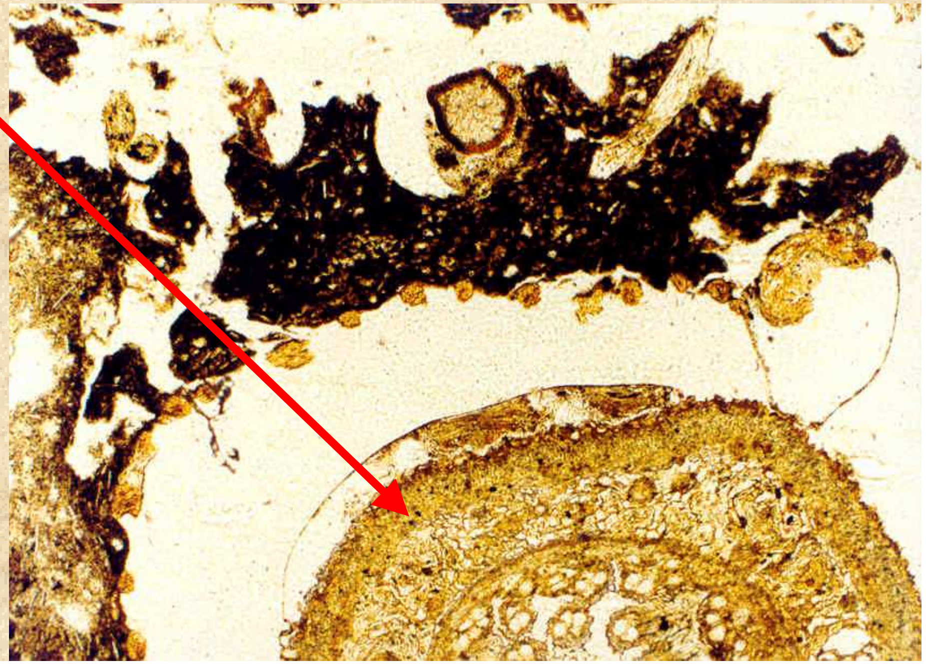




Spontaneous succession - 40 years old plot



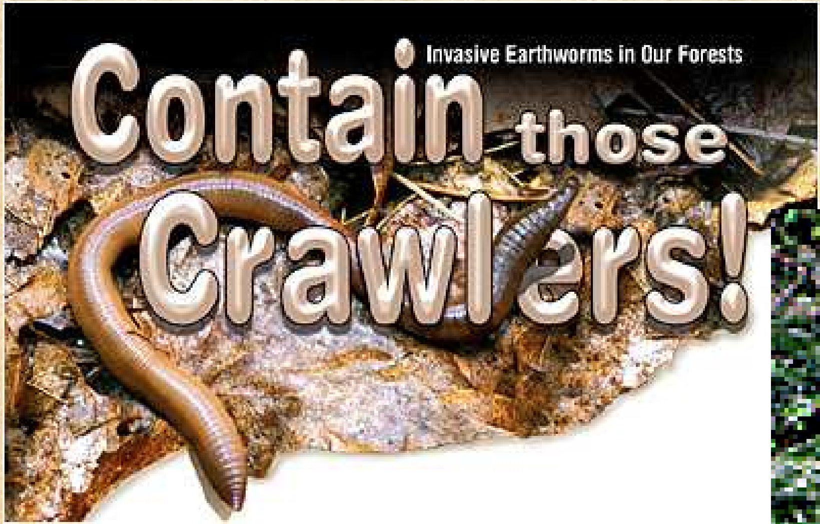


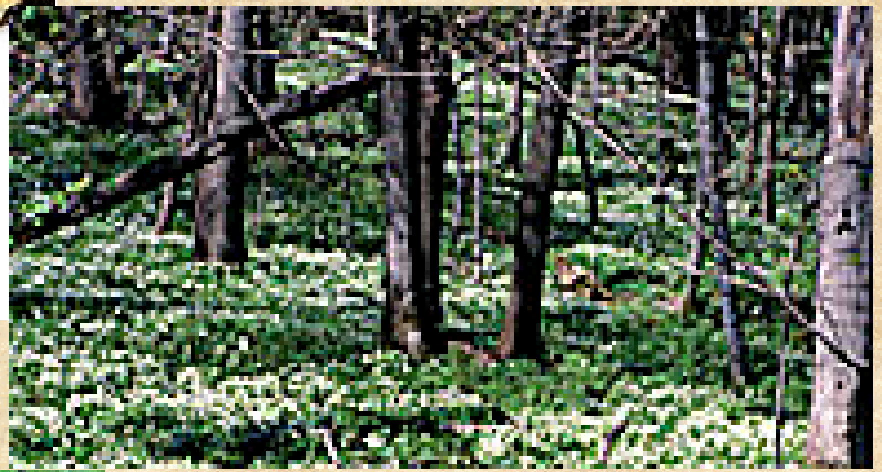


Rekultivováno

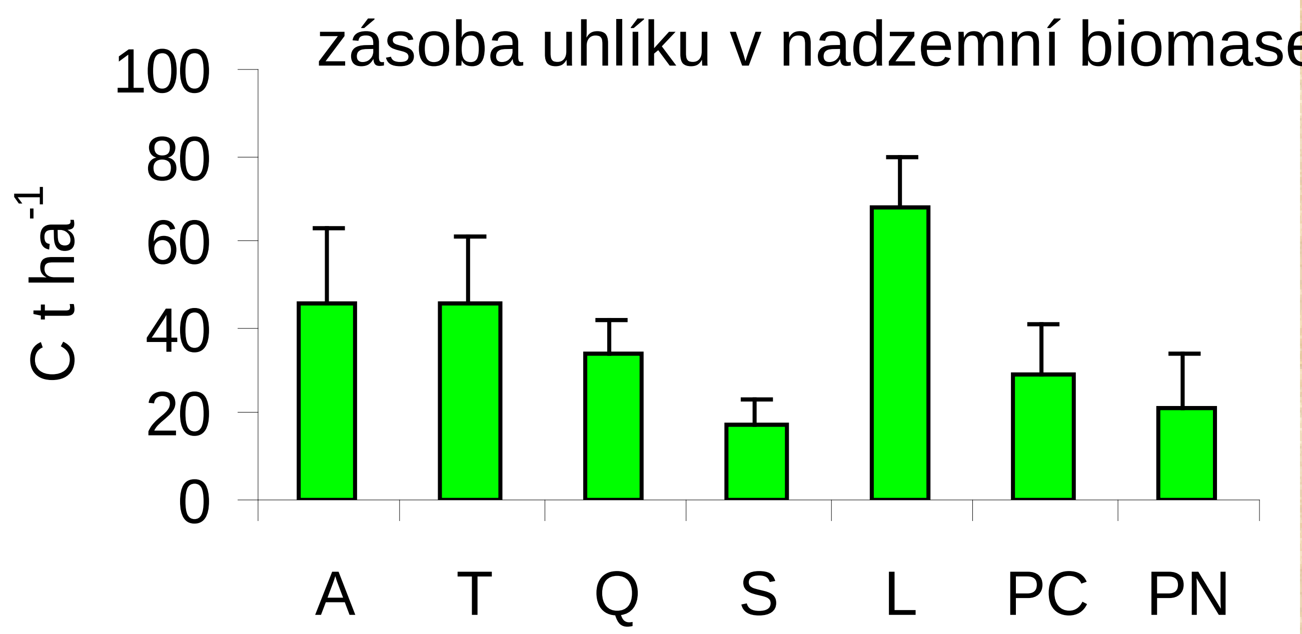
Nerekultivováno

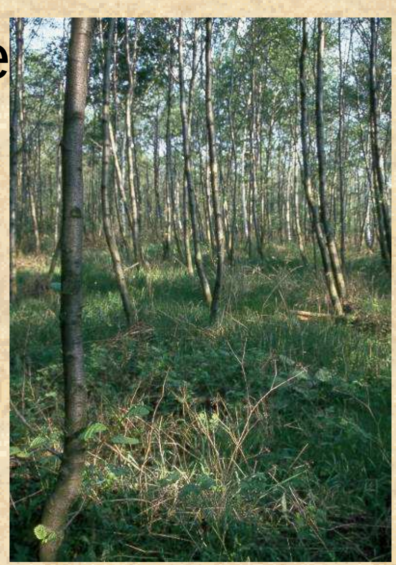
Evropské žížaly v Sev.Americe

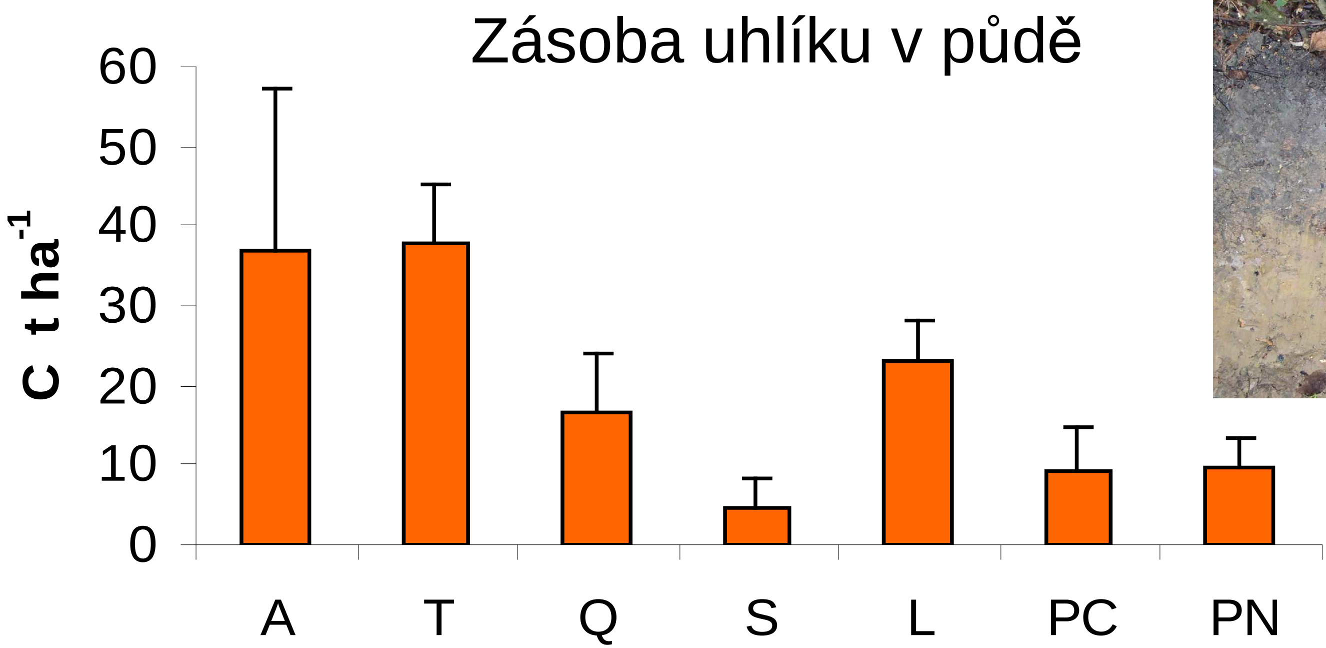




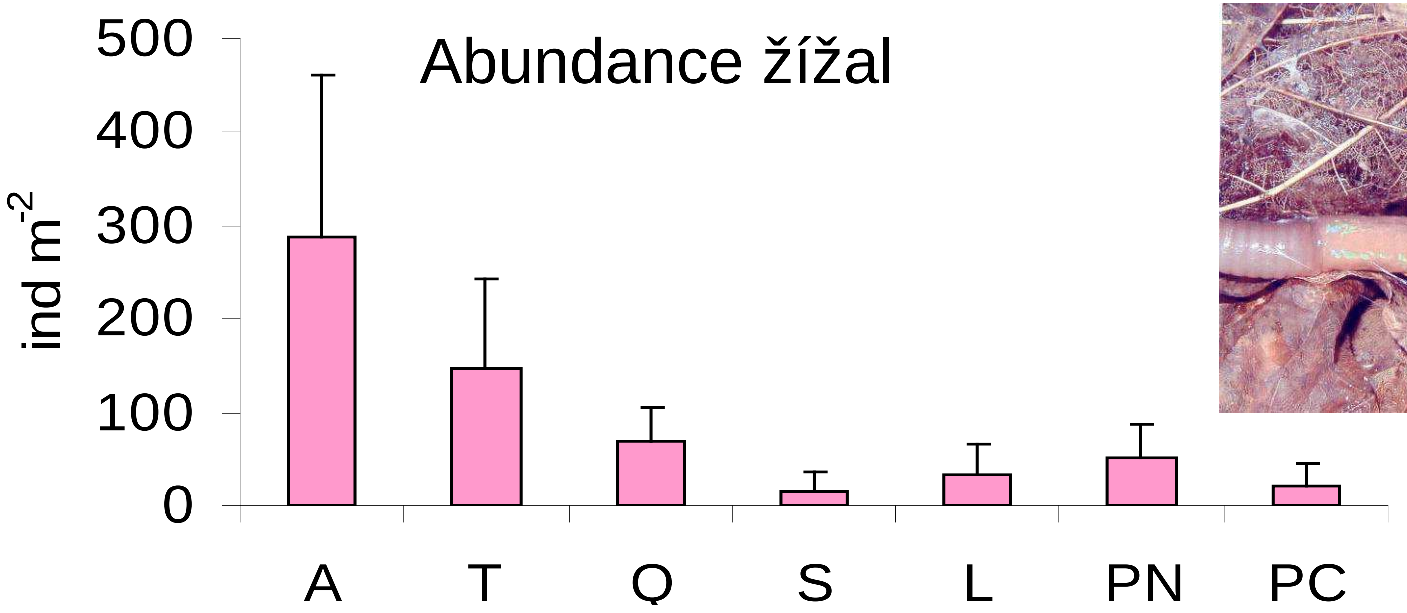
Porovnání vývoje půd pod různými druhy dřevin.

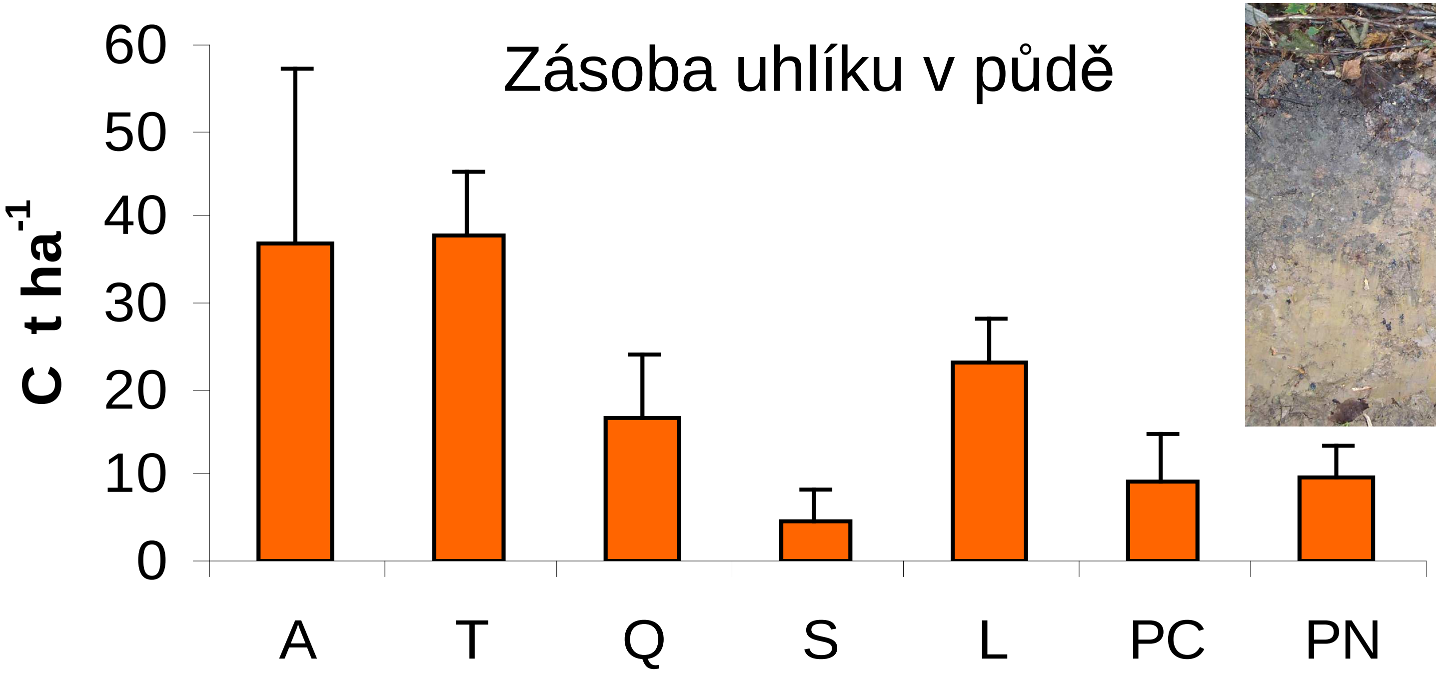


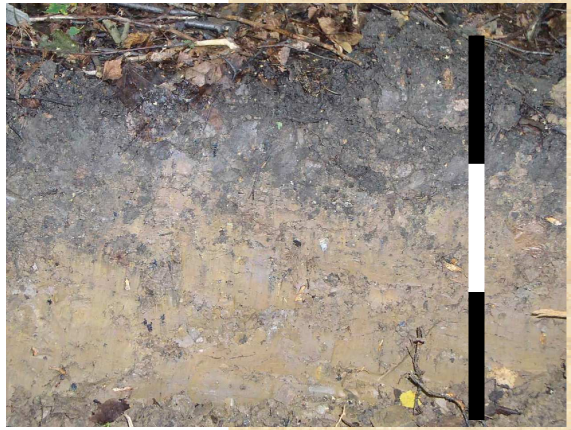




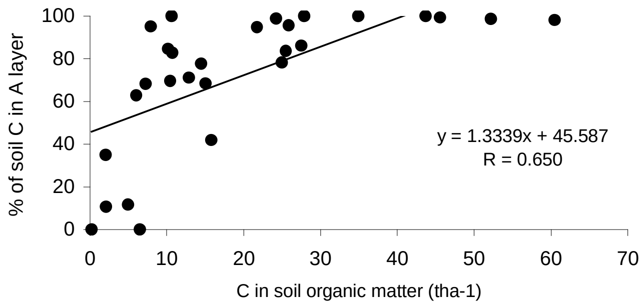
22-32
year
old sites

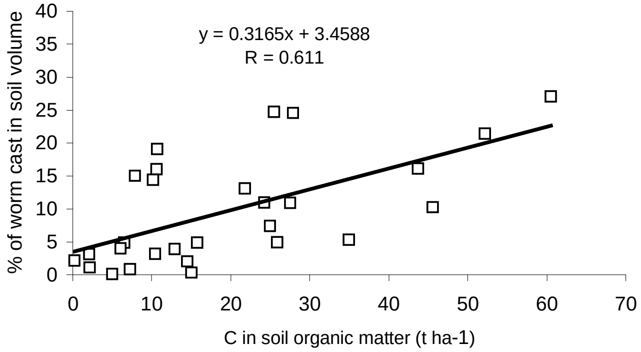


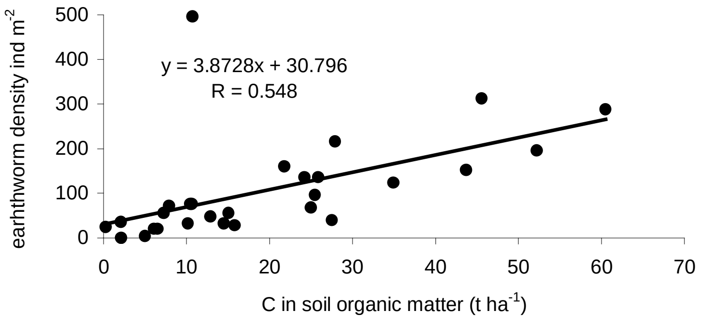


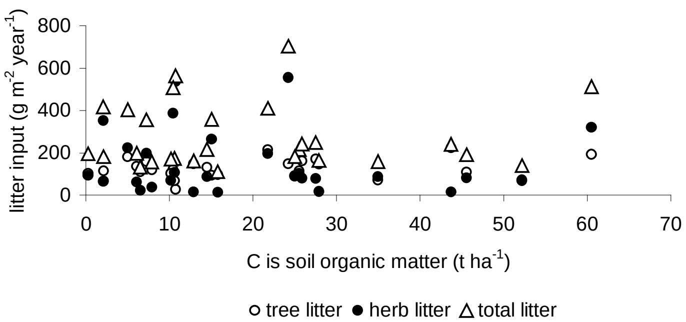


22-32
year
old sites


% of soil C in A layer
C in soil organic matter (tha-1)
y = 1.3339x + 45.587
R = 0.650

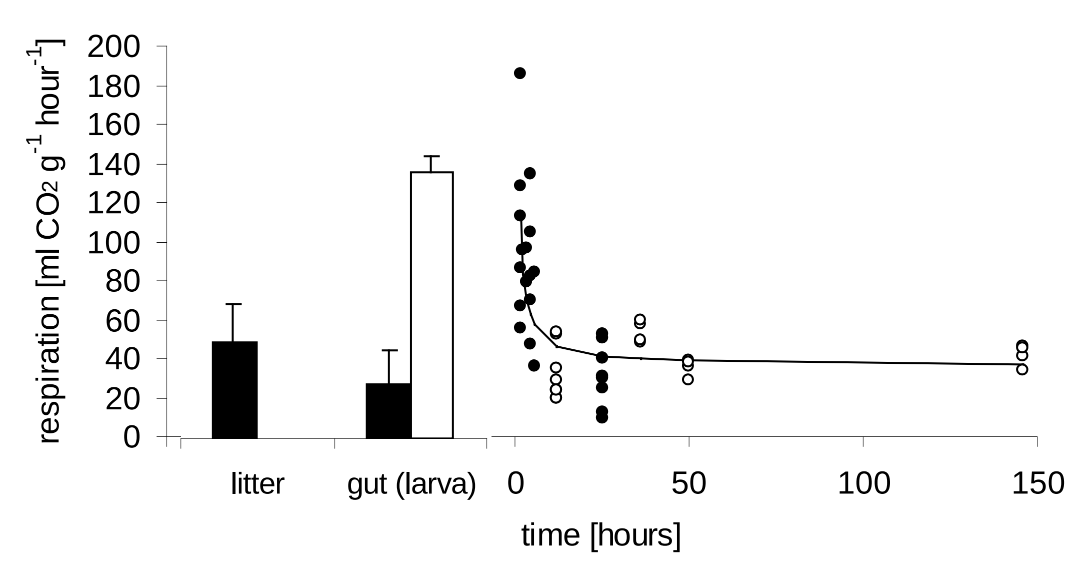

% of worm cast in soil volume
C in soil organic matter (t ha-1)
y = 0.3165x + 3.4588
R = 0.611

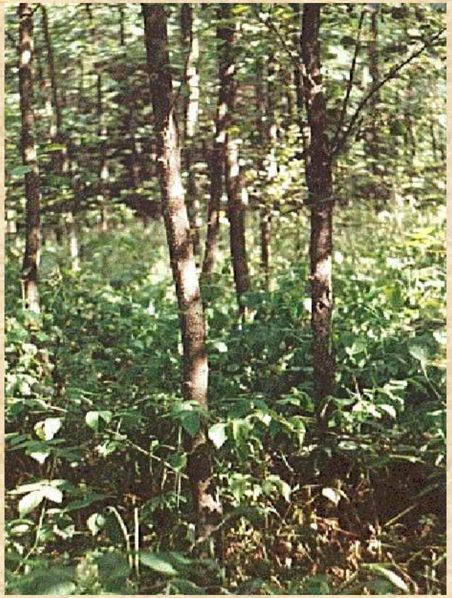

earhthworm density ind m-2
C in soil organic matter (t ha-1)
y = 3.8728x + 30.796
R = 0.548

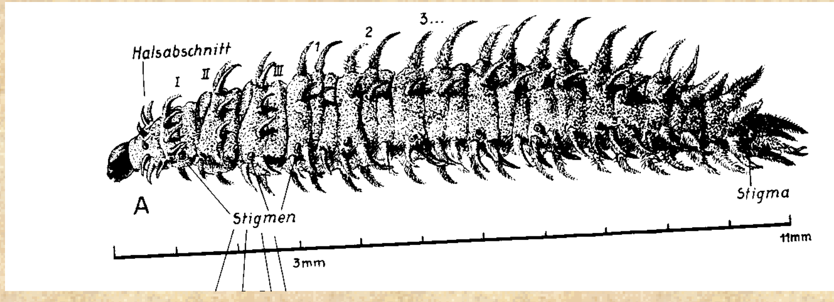

litter input (g m-2 year-1)
C is soil organic matter (t ha-1)
tree litter
herb litter
total litter

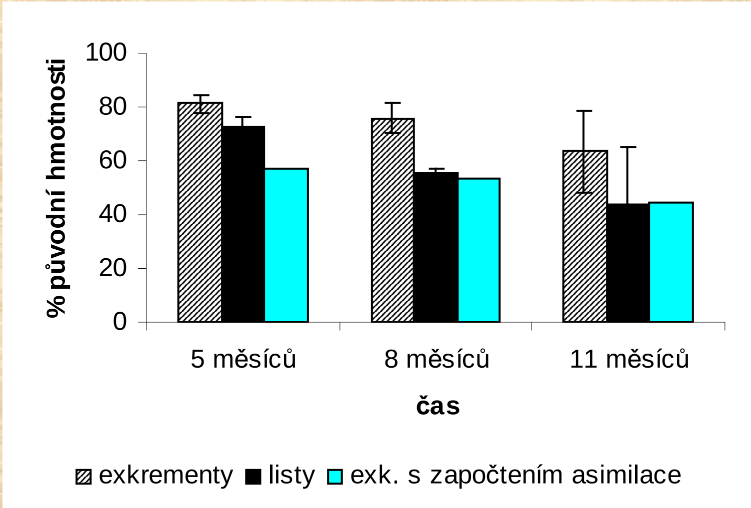

LF (Oa Oe)
A

Půdní fauna krátkodobě urychluje ale dlouhodobě zpomaluje dekomposici - přispívá k akumulaci organické hmoty v půdě

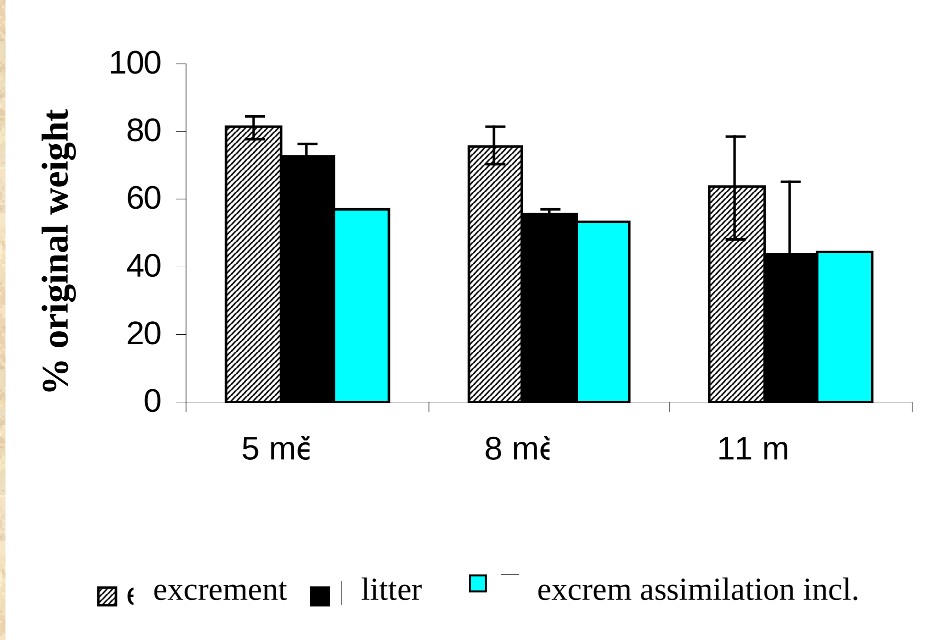








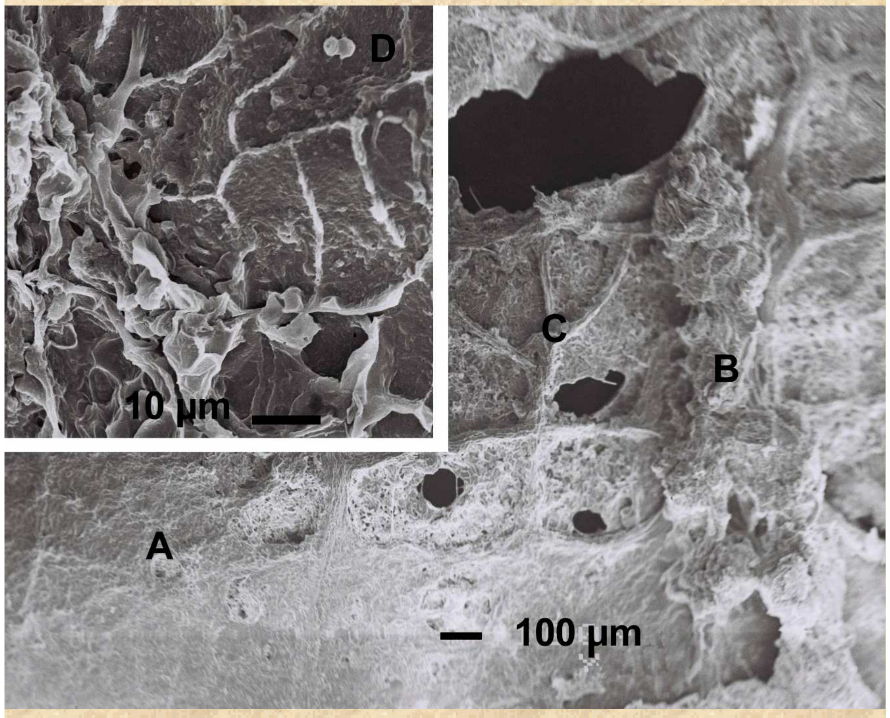
In long term decomposition of excremens is slower tnan decomposition of leaf litter

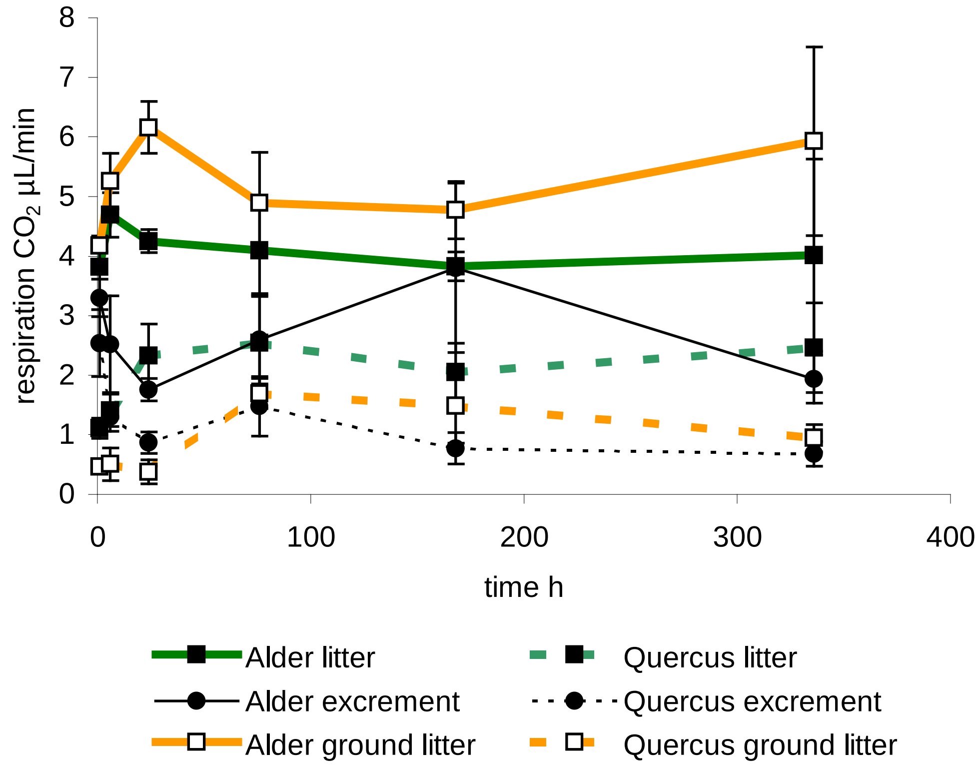


Fragmentace opadu

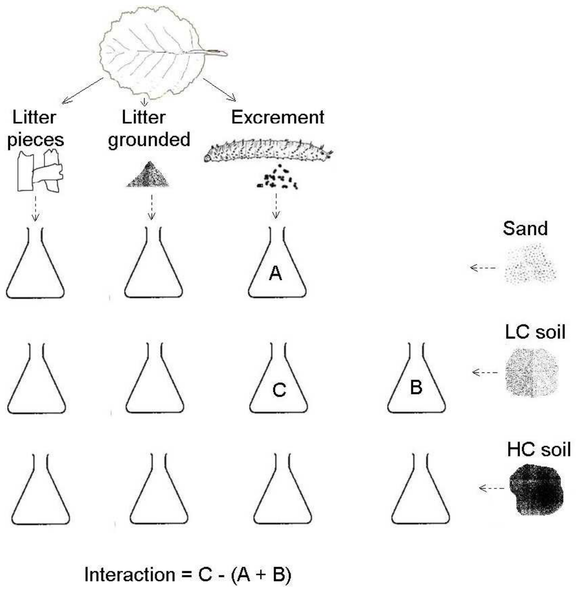
Fragmentace opadu zvětšuje jeho povrch a rychle zpřístupňuje místa kam by se mikrorganismy dostali až za delší dobu.

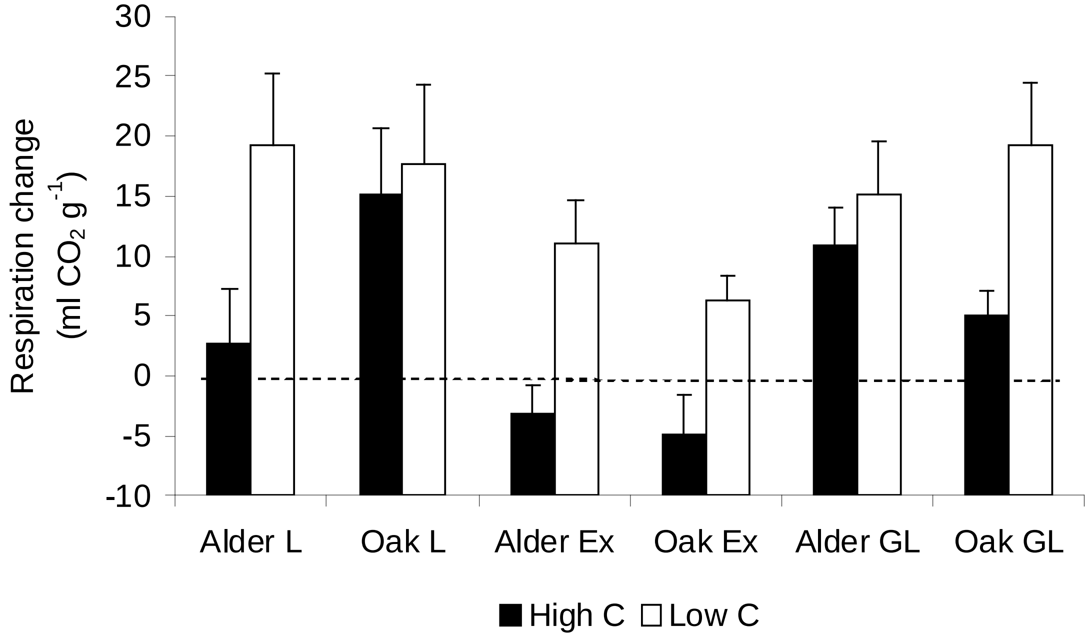
Ale u některých druhů opadu může fragmentace podpořit uvolnění fenolů a zpomalit dekomposici



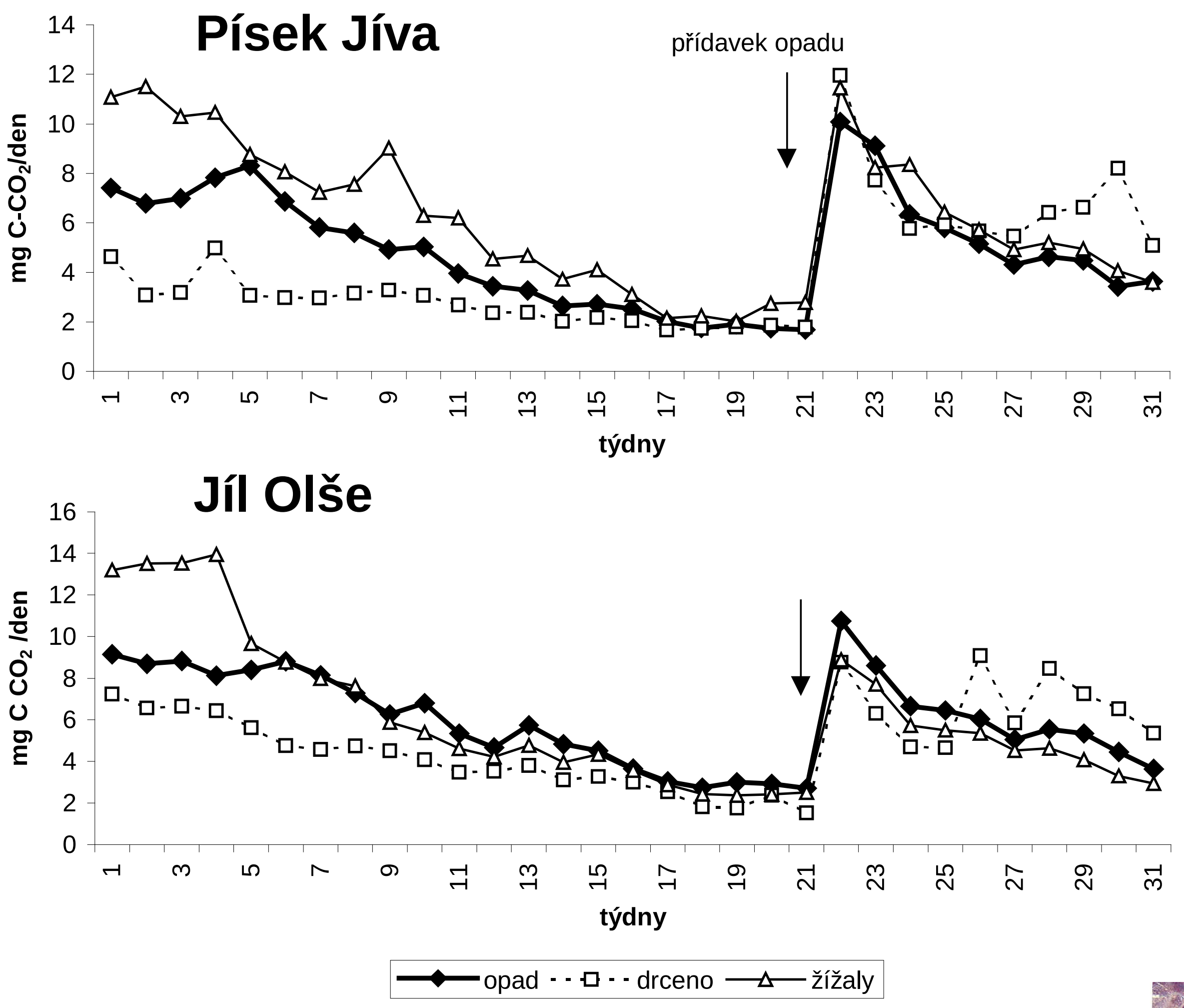


Introduction of Bibio fecal pellets in to soil cause smaller increase of soil respiration than litter addition

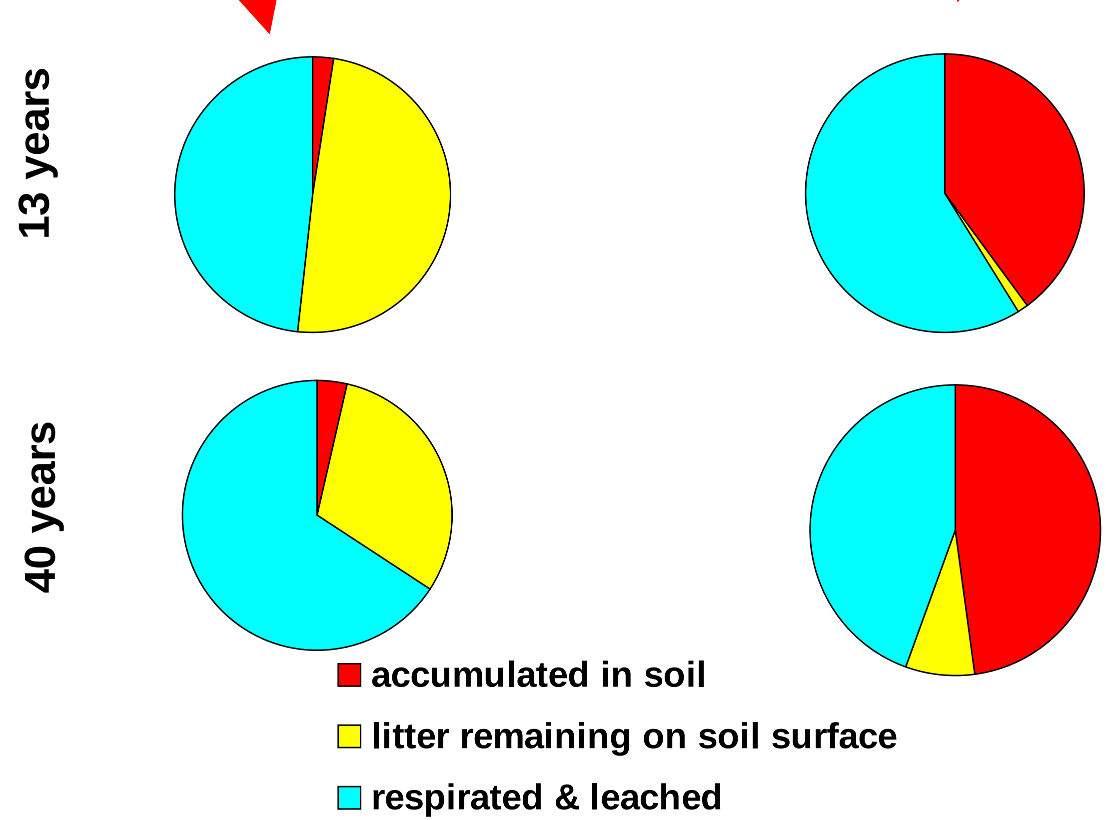


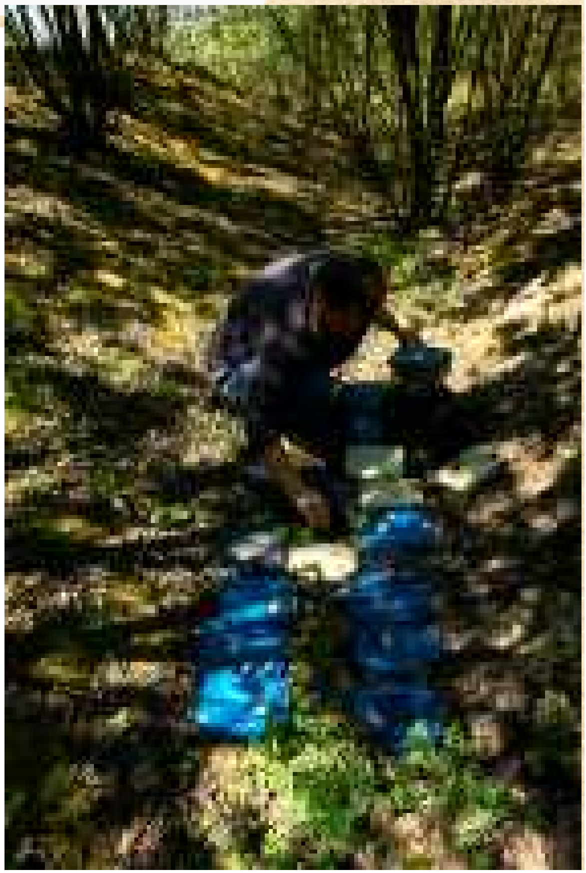


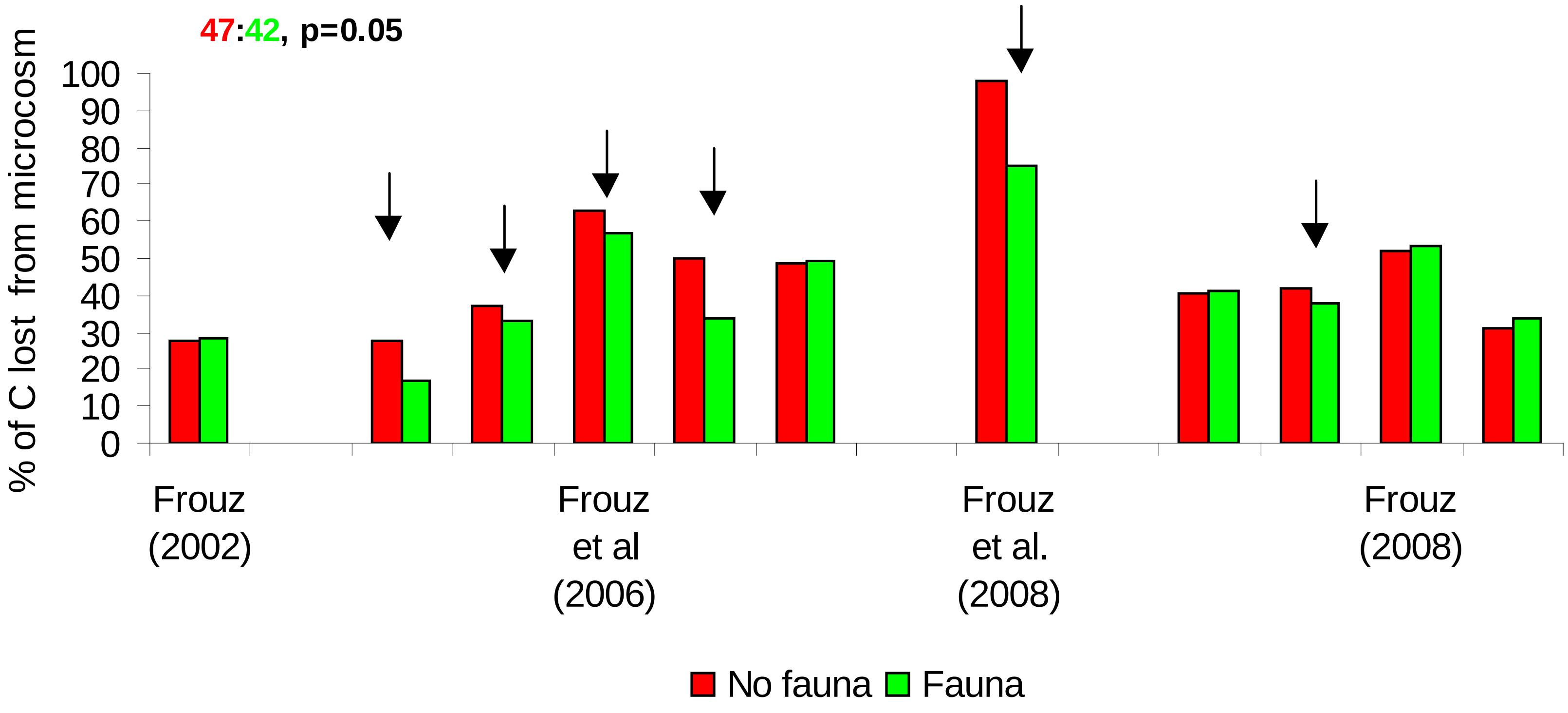
	F	df		p
Tree species	0.1	1	47	ns
Litter vs excrement	6.2	2	47	0.00475
Soil C content	13.0	1	47	0.00092


Písek Jíva
přídavek opadu
mg C-CO2/den
týdny
Jíl Olše
mg C CO2 /den
týdny
opad
drceno
žížaly

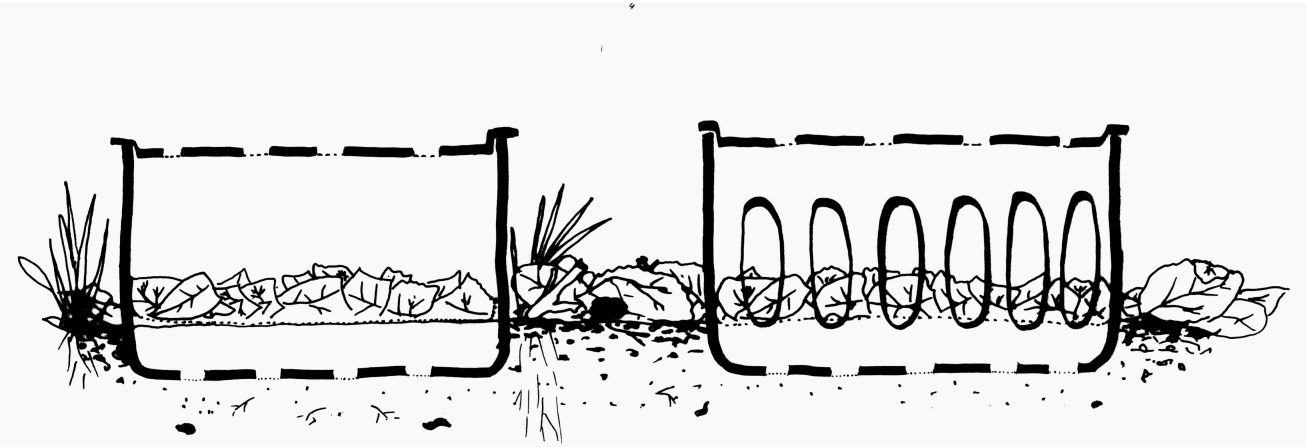
Macrofauna excluded | **Accessible for macrofauna**

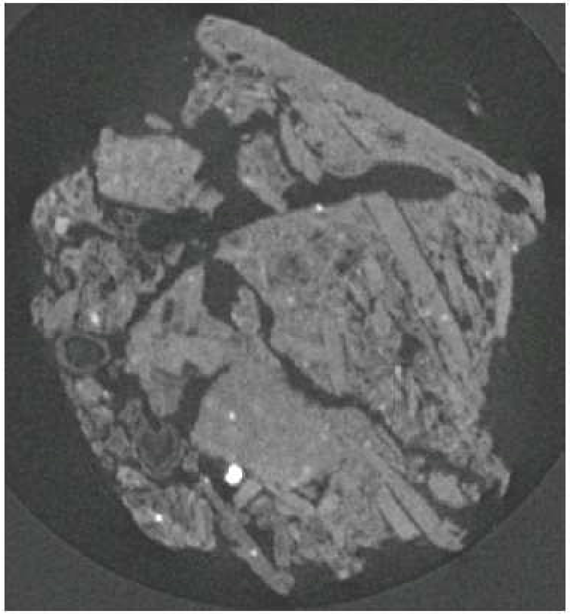




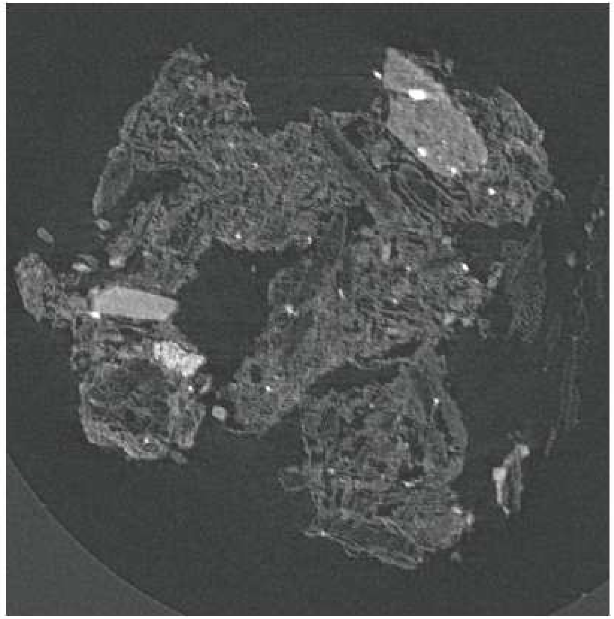


47:42, p=0.05
% of C lost from microcosm
100
90
80
70
60
50
40
30
20
10
0
Frouz
(2002)
Frouz
et al
(2006)
Frouz
et al.
(2008)
Frouz
(2008)
No fauna
Fauna



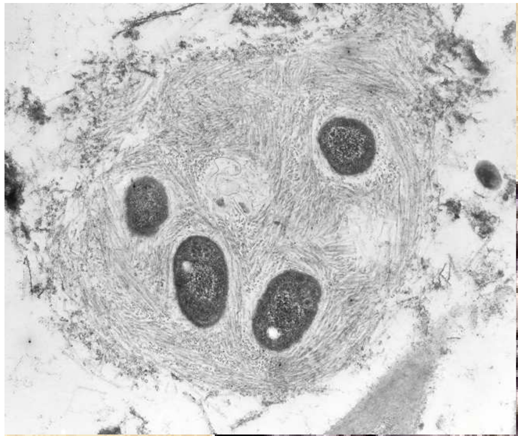


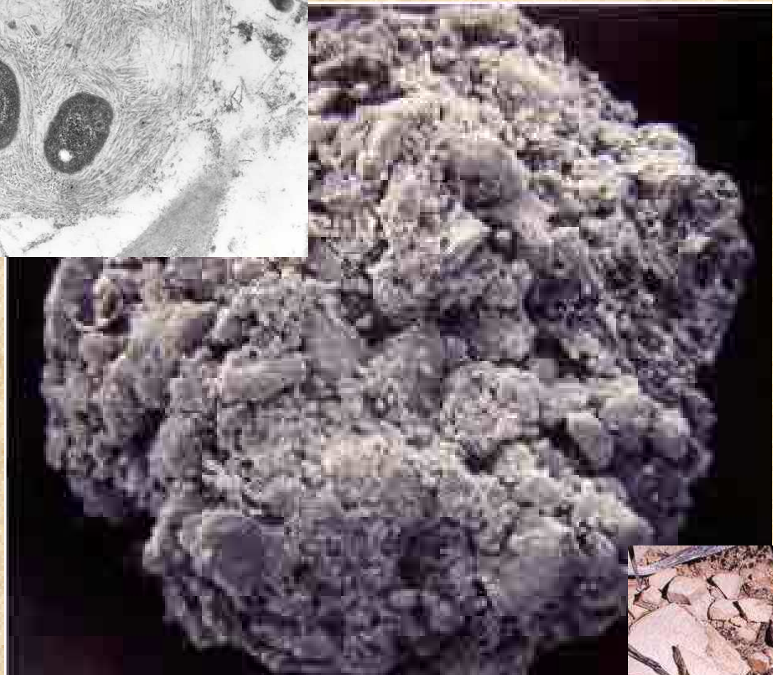
Other aggregates

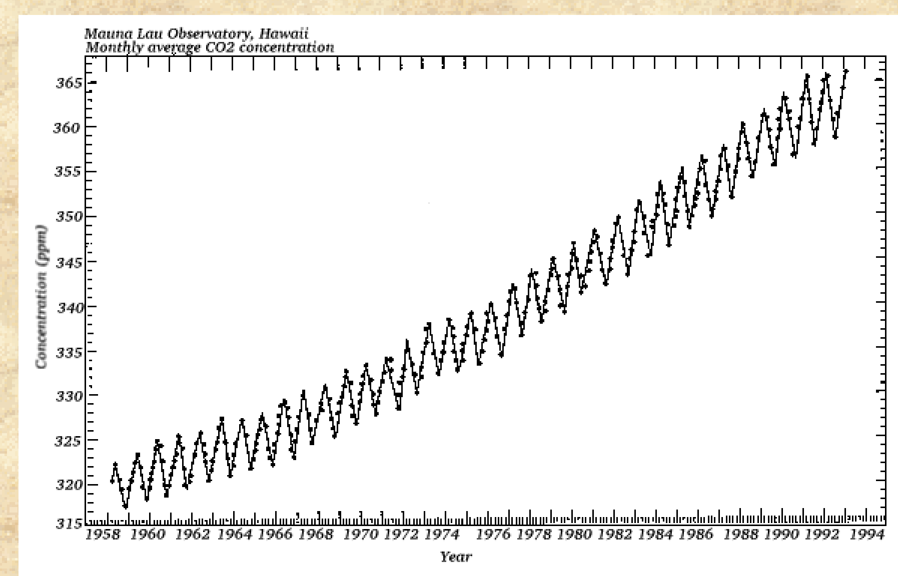


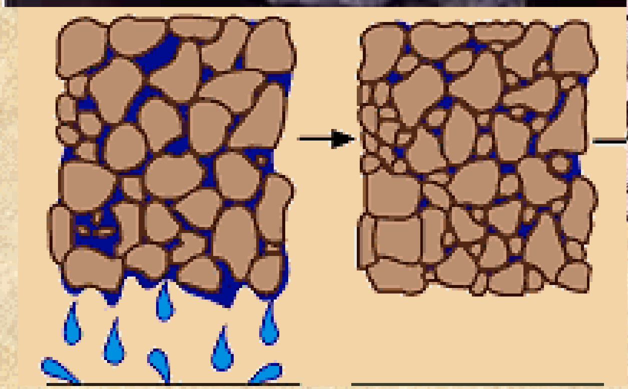
Earthworm created aggregates

	prismatic	spherical
Light POM	0.34±0.21	0.84±0.55
Bounded light POM	0.18±0.12*	1.34±0.43*

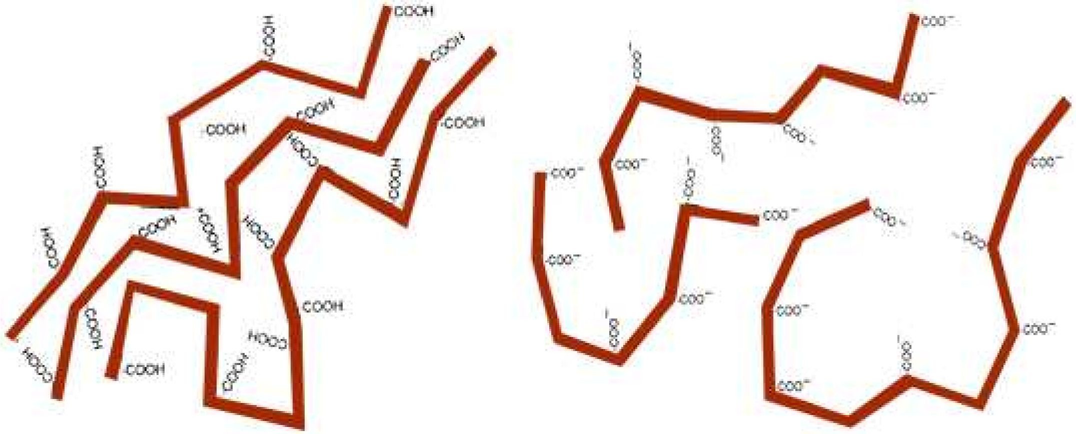


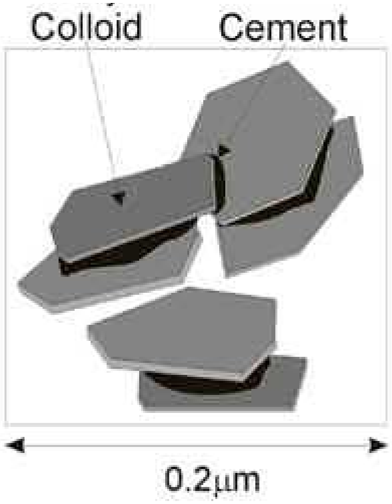



Mauna Lau Observatory, Hawaii
Monthly average CO2 concentration
Concentration (ppm)
315
320
325
330
335
340
345
350
355
360
365
1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994
Year

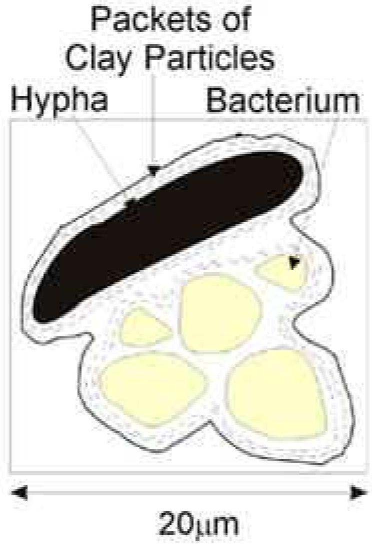


At low pH - flocculated **At high pH - dispersed**

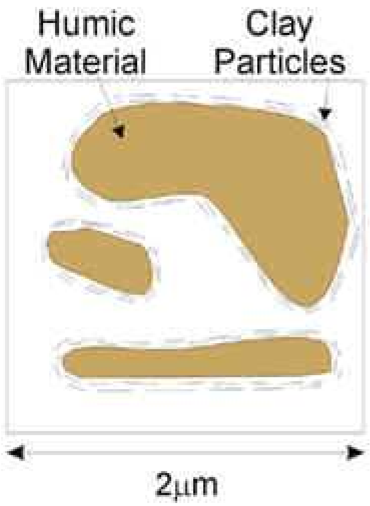




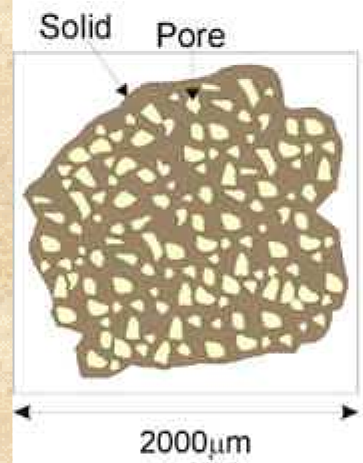
- Amorphous aluminosilicates, oxides and organic polymers sorbed on clay surfaces and electrostatic bonding, flocculation

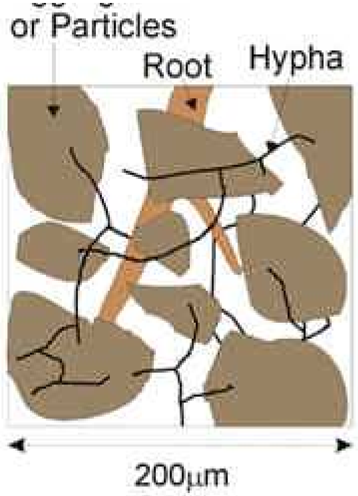


- Plant and fungal debris



- Microbial and fungal debris encrusted with inorganics

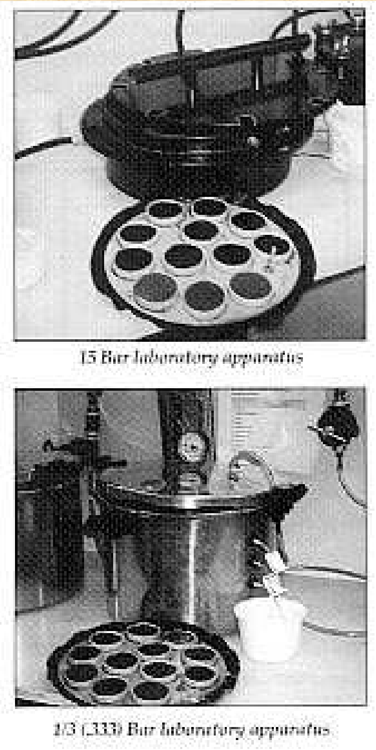


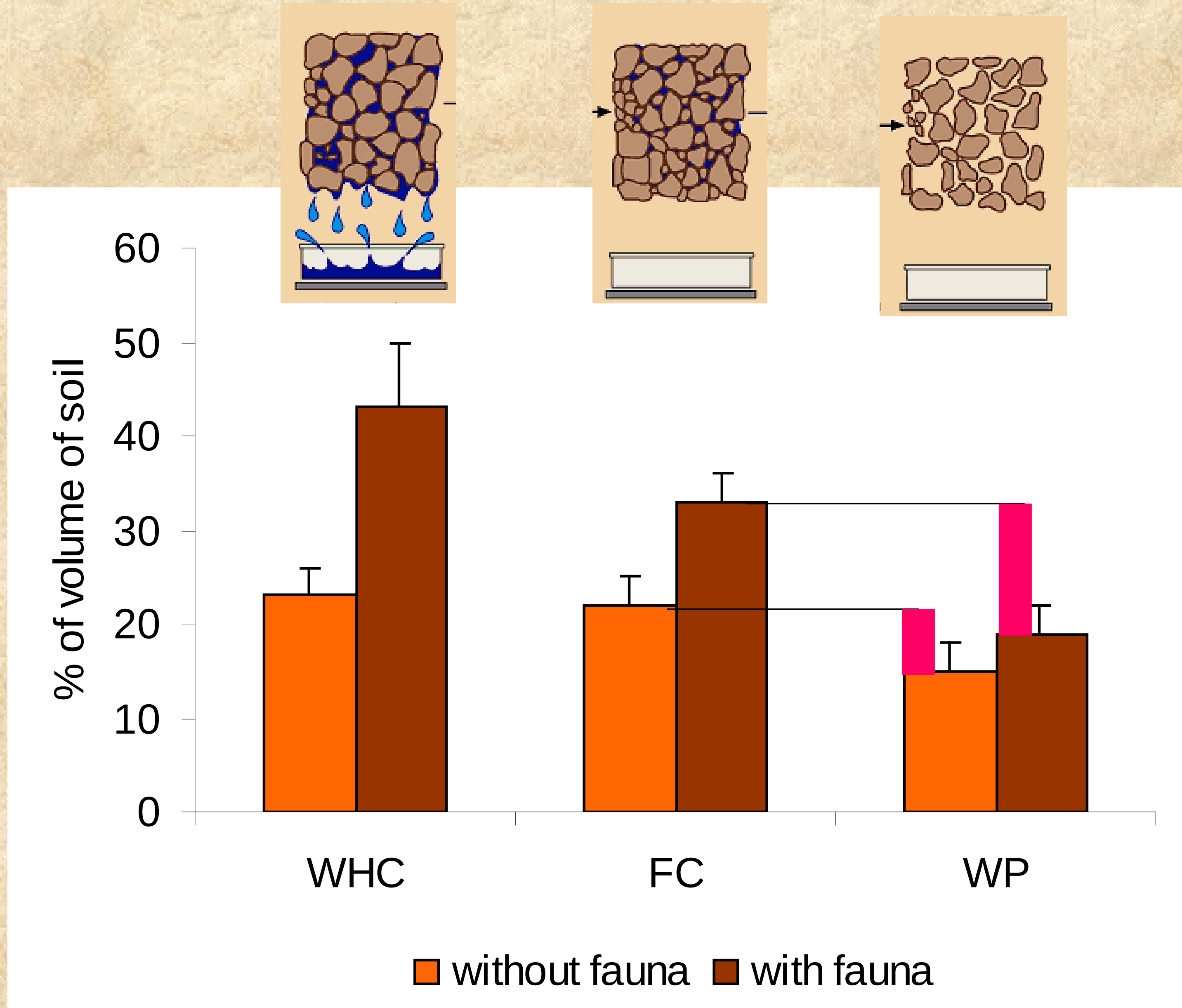


Major binding agents:

- Roots and hyphae

Effect of SOM accumulation on soil water budget





Vltavská kaskáda při maximálním vzdmutí cca **820** mil m^3
Půdní voda v povodí Vltavy (28090 km^2) do hloubky 0,5m
(25% objemu půdy) cca **3370** mil m^3

odvodnění

- Snižuje vlhkost půdy
- zvyšuje dostupnost pro techniku
- zvyšuje teplotu
- urychluje mineralizaci OH
- poměr povrchového a podpovrchového odtoku

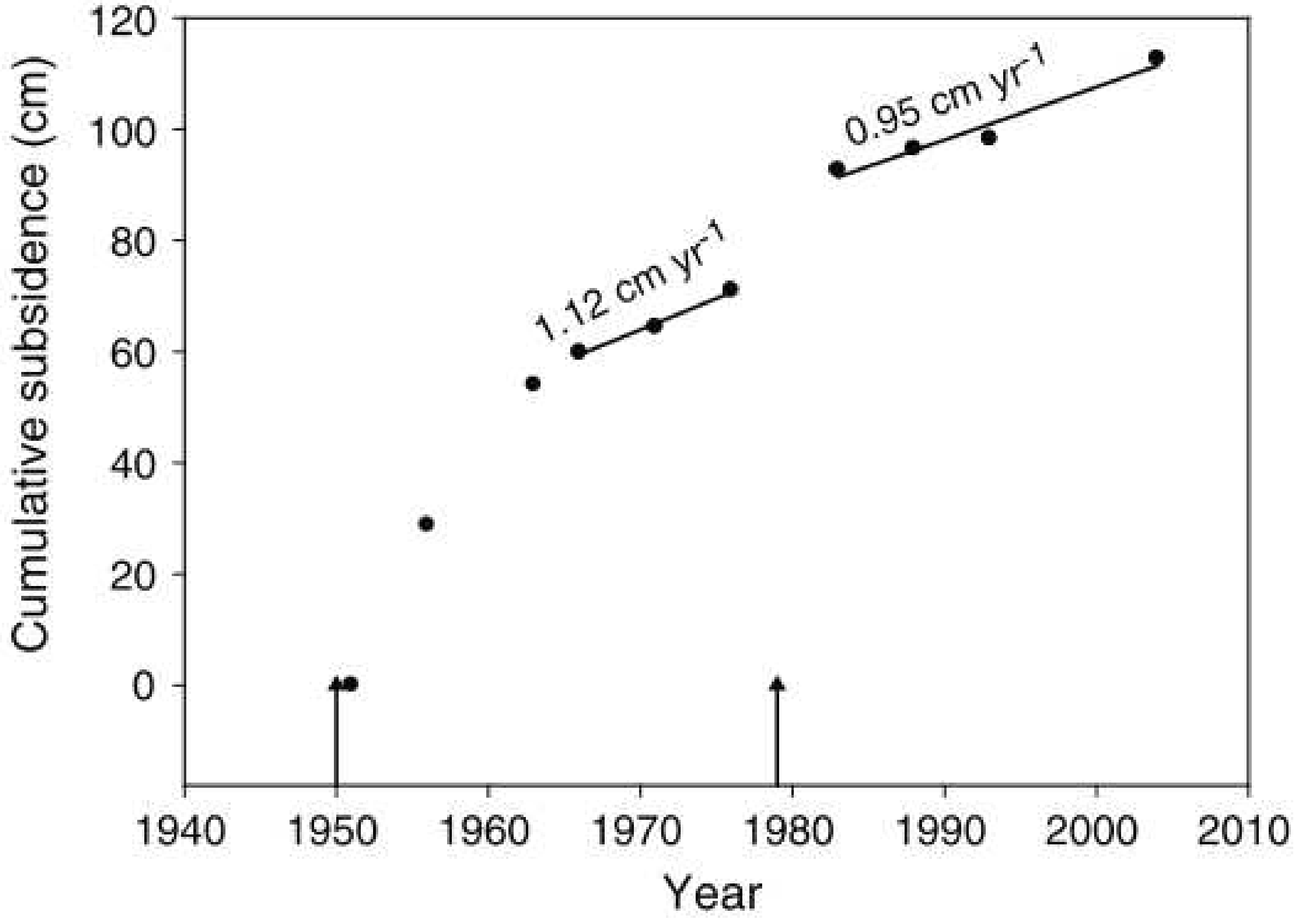


Fig. 2 Cumulative peat subsidence following drainage at Smøla Island. The field was drained about 1950 and at the end of the 1970s (arrows)

Table 7 Estimated soil organic matter (SOM) and C losses from cultivated peatlands

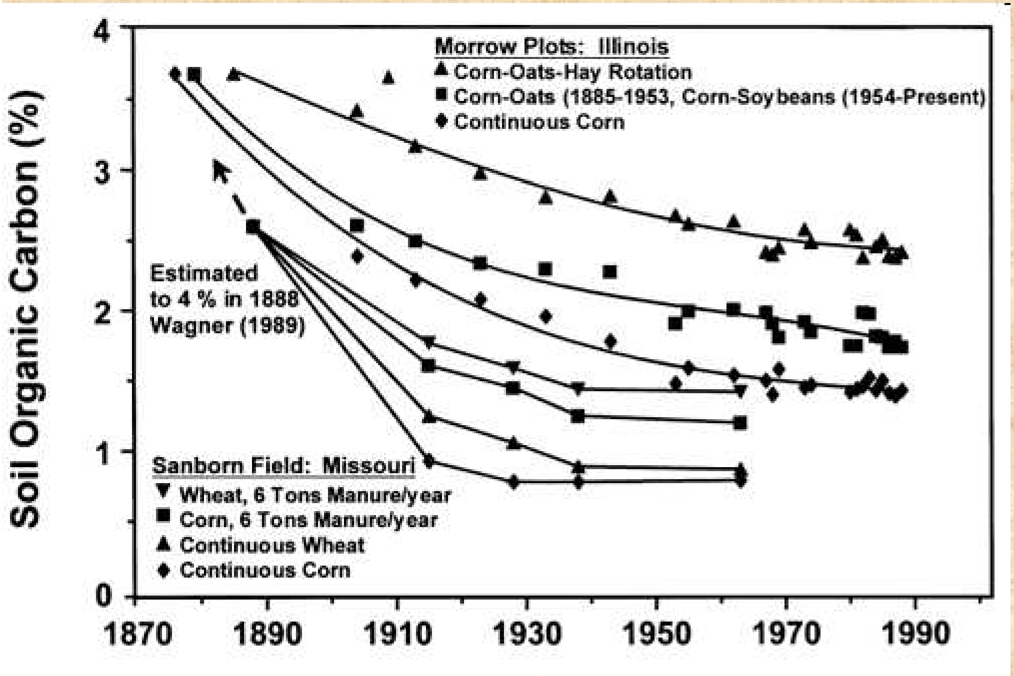
Method	Data set	Total loss		Annual loss ($kg\ C\ m^{-2}\ year^{-1}$)
		$kg\ SOM\ m^{-2}$	$kg\ C\ m^{-2}$	
Subsidence	5 county (28 years)	44	22	0.80
Mineral content	5 county (28 years)	47	24	0.86
CO_2 flux	Bodø, Nordland county			0.60

Table 1. Comparison of soil physical and chemical properties in undrained and drained patches near Senotín (Czech Republic).

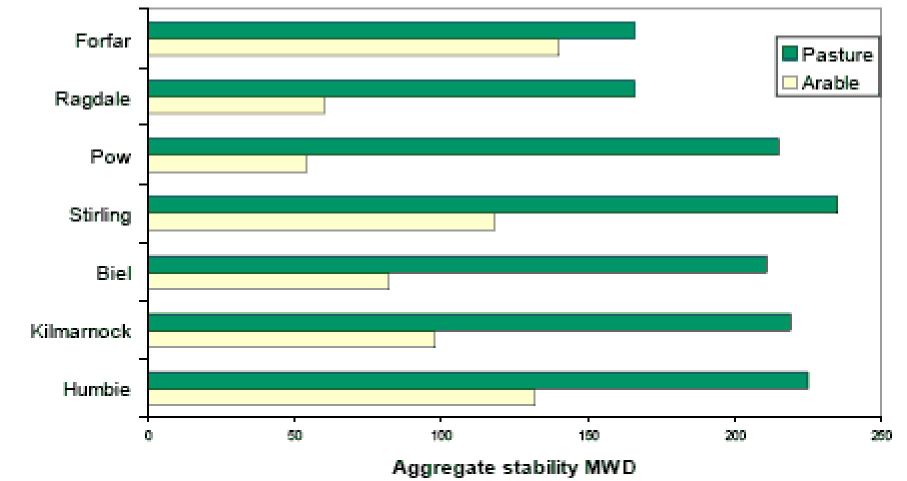
	undrained					drained					T test
	min	max	Mean	SD	N	min	max	Mean	SD	N	p
sil moisture % [1]	31	715	119	114	30	14	60	36	11	30	0.0002
water level depth cm	0	100	32	30	30	4	85	34	23	30	0.7833
bulk density g cm-3	0.2	0.6	0.32	0.13	7	0.7	1.5	1.07	0.23	7	0.0001
specific density g cm^{-3}	1.2	2.3	1.59	0.34	7	2	2.5	2.27	0.17	7	0.0025
porosity % [2]	63.6	89.1	79.95	8.14	7	41	65.7	53.29	7.38	7	0.0001
water holding capacity % [2]	62.7	90.4	76.42	8.8	7	29.6	69.3	56.73	11.72	7	0.0072
field capacity % [2]	42	75.1	58.47	12.6	7	39.9	57.4	50.34	5.848	7	0.1768
stones above 2mm	0	29.1	8.54	11.5	5[3]	14.0	35.3	20.4	6. 7	7	0.1131
clay <0.01 mm	3.4	18.6	10.24	5.8	5[3]	1.7	18.6	11.6	5.6	7	0.7202
silt 0.01-0.05 mm	9	32.2	20.1	7.7	5[3]	18.6	28.8	22.1	3.2	7	0.6412
fine sand 0.05 –0.1 mm	12.7	18.6	14.58	2.1	5[3]	5.1	15.3	11.5	3.9	7	0.1455
sand 0.1 mm – 2 mm	33.1	74.6	54.76	14.9	5[3]	40.7	66.1	54.7	8.6	7	0.9971
pH	3.72	5.22	4.76	0.48	7	4.78	5.79	5.18	0.35	7	0.1076
Conductivity mS cm-1	0.08	0.25	0.167	0.06	7	0.05	0.15	0.08	0.03	7	0.0422
P total mg kg-1	743	1596	1346	279	7	699	1459	930	252	7	0.0130
P availabe mg kg-1	18	79	39	23	7	3	40	15	13	7	0.0528
P watersoluble mg kg-1	13	75	34	23	7	1	14	6	4	7	0.0221
Mg available mg kg-1	107.6	171.2	149.4	19.8	7	36.3	163.5	107.7	50.2	7	0.0981
Cox %	7.42	29.06	19.04	6.79	7	2.95	11.32	5.32	3.19	7	0.0018

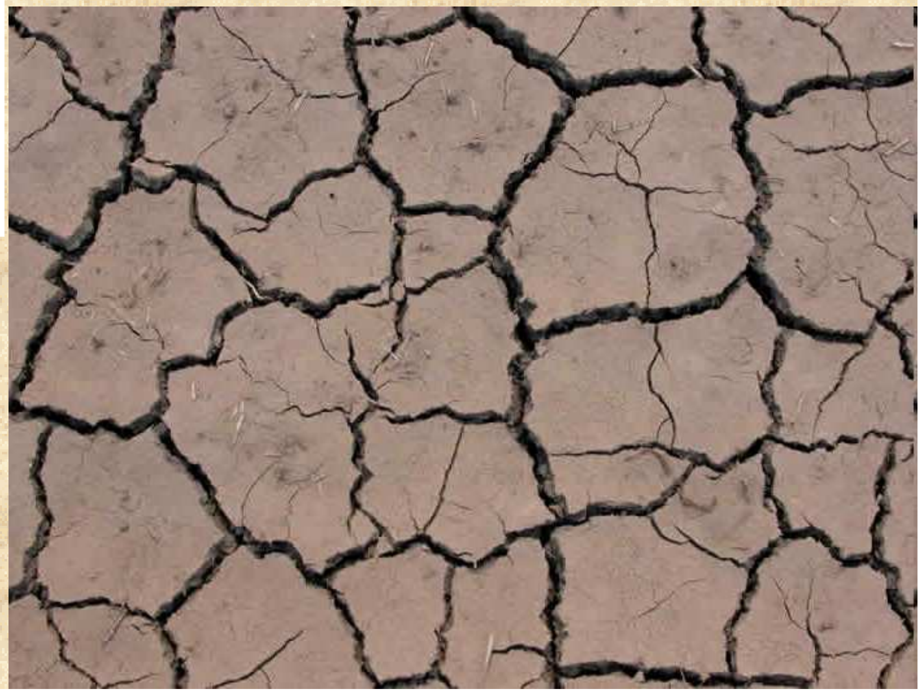
Orba

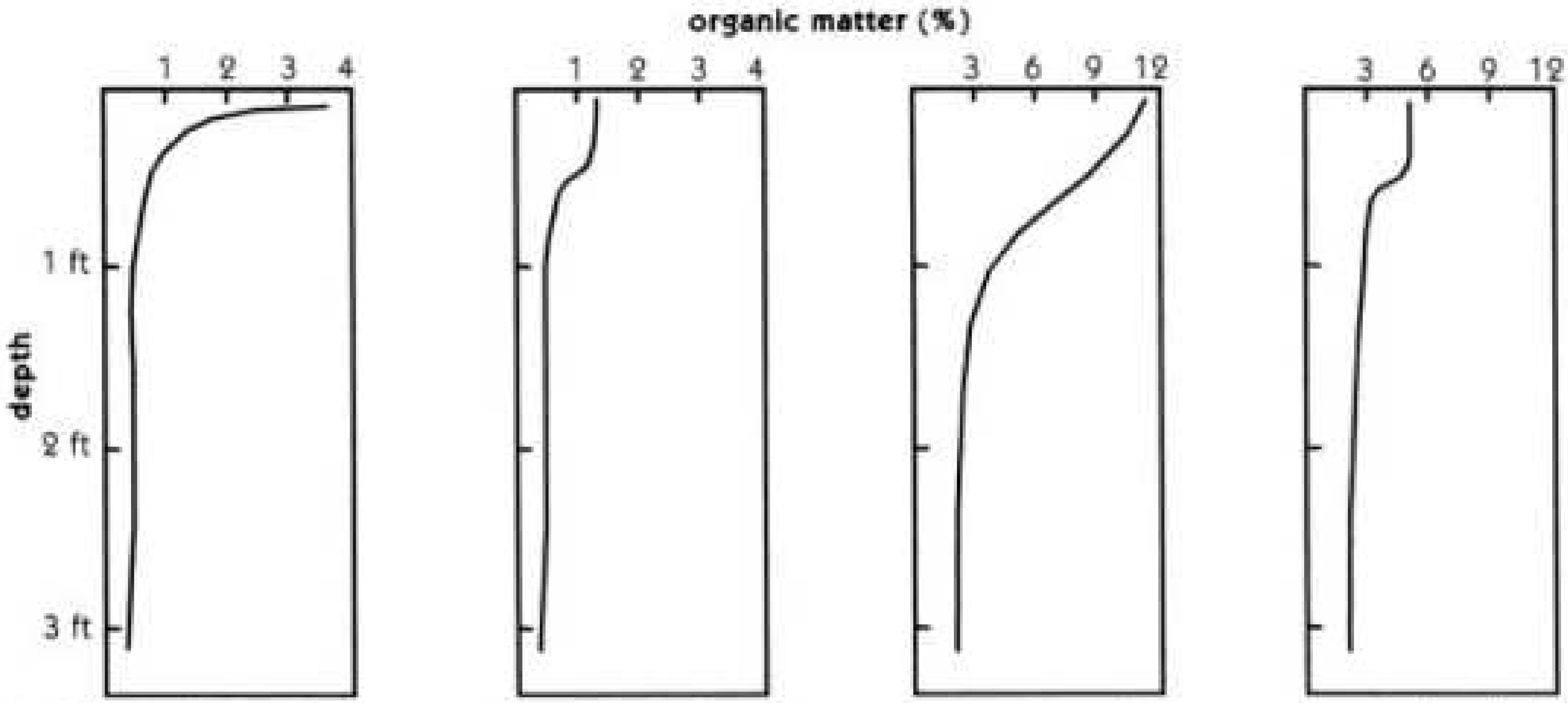
Nebezpečí kultivace



Ztráta organické hmoty
omezení činnosti edafonu
ztráta půdní struktury
utužení
seeling
eroze







a) forest soil (litter layer on top of mineral soil may be 30% or more organic)

b) agricultural soil (originally forest)

c) prairie soil

d) agricultural soil (originally prairie)

Co můžeme udělat

- Rotace plodin
- větší podíl TTP a DTP
- omezení plochy neporostlé půdy (meziplodiny zelené hnojení
- větší přísun OH do půdy
- bezorebné technologie

Bezorebné technologie

- Výnos někdy větší někdy menší
- Úspora energie
- Menší erose větší zadržení vody v krajině
- Sequestrace uhlíku
- rozvoj půdní bioty
- horší potlačení plevelů
- složitější agrotechnika
- nižší teplota půdy zejména na jaře

Země s největší výměrou bezorebných technologií			
země	plodina	výměra mil. ha	% celkové výměry
USA	celkem	22,3	20
	soja	10,5	45
	kukuřice	6,1	19
Brasilie	celkem	13,5	21
Argentina	celkem	9,5	32
Australie	celkem	8,7	-
Kanada	celkem	4,1	-
Paragvay	celkem	1,0	52

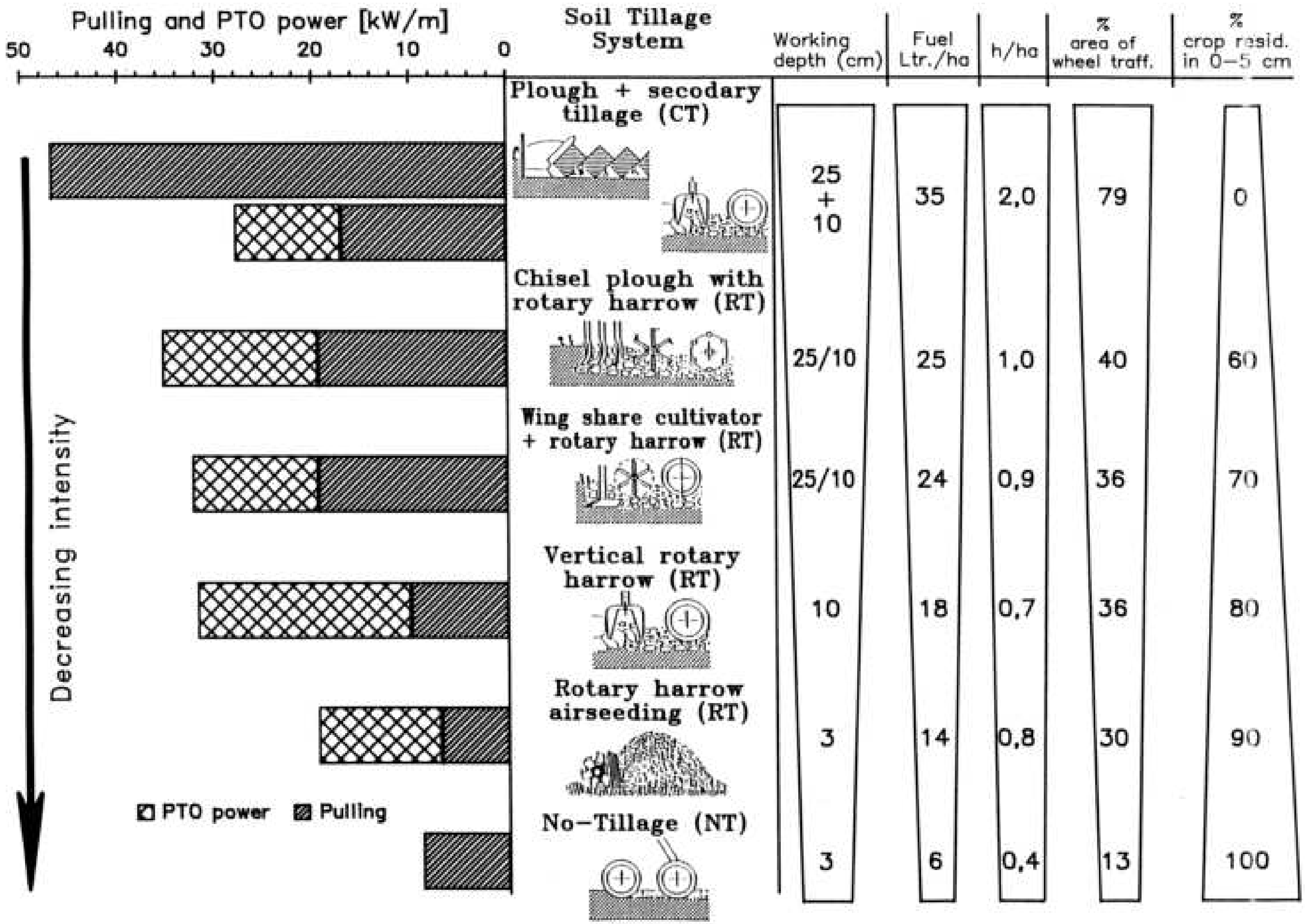


Fig. 2. Applied tillage systems and their effects on performance and requirements. Impact on soil depth and soil surface.

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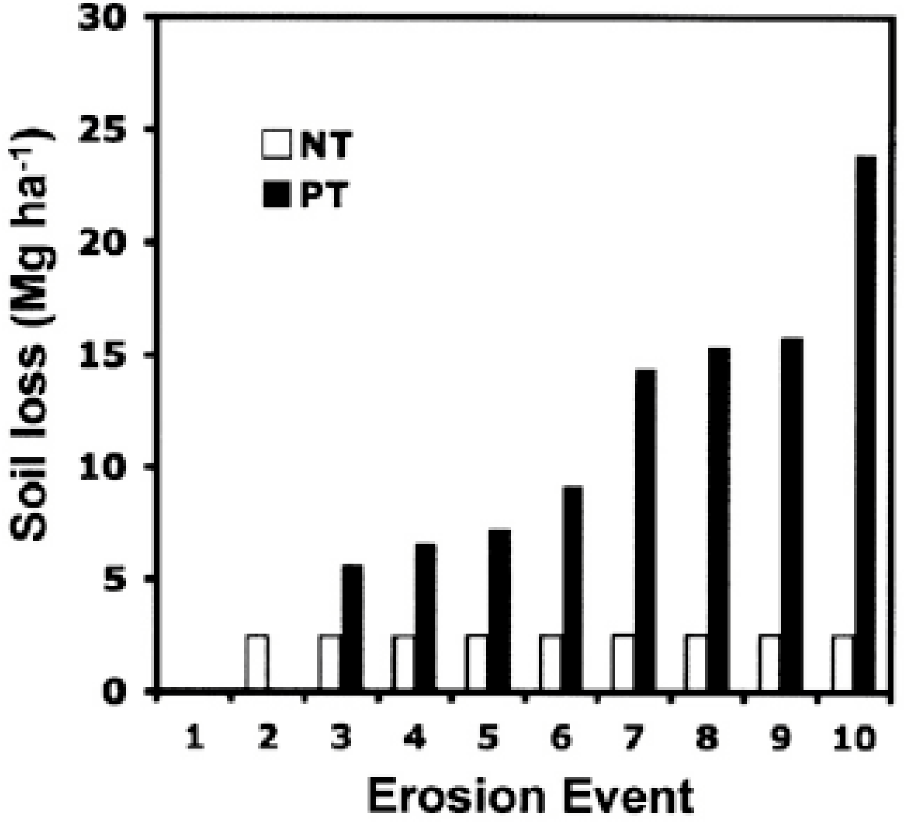


Fig. 1. Cumulative soil loss from NT and PT watersheds at Coshocton, OH, for the years of 1970–1973. The erosion events are all rainfall events that produced runoff and erosion during this time period. To visualize the NT values, they were multiplied by 10 before being plotted in the graph (from Harrold and Edwards, 1974).

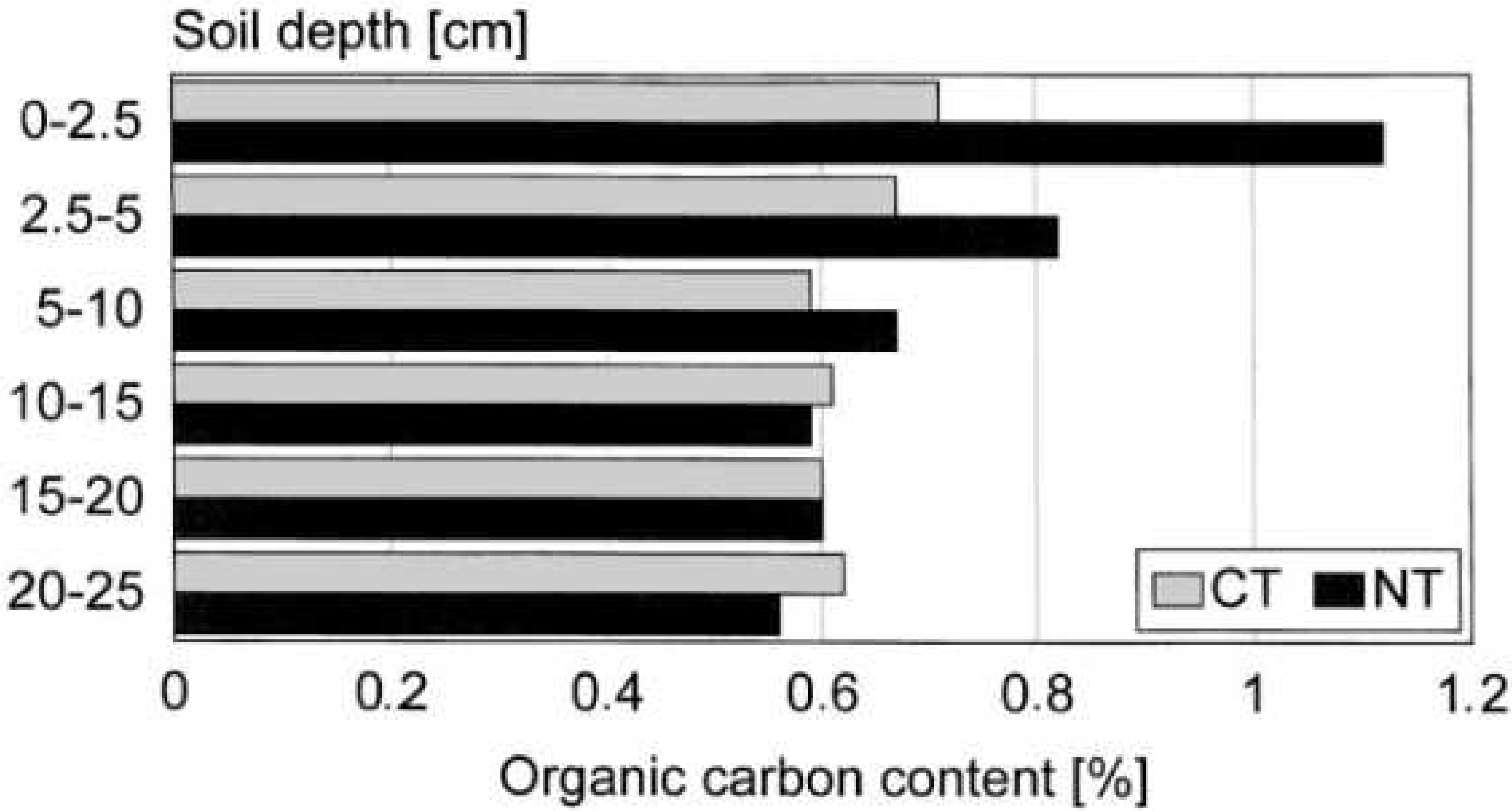


Fig. 3. Effect of long-term applied tillage systems on organic matter contents in soil, expressed by the content of organic carbon in the top soil of the Eutric Cambisol (according to Grocholl, 1991).

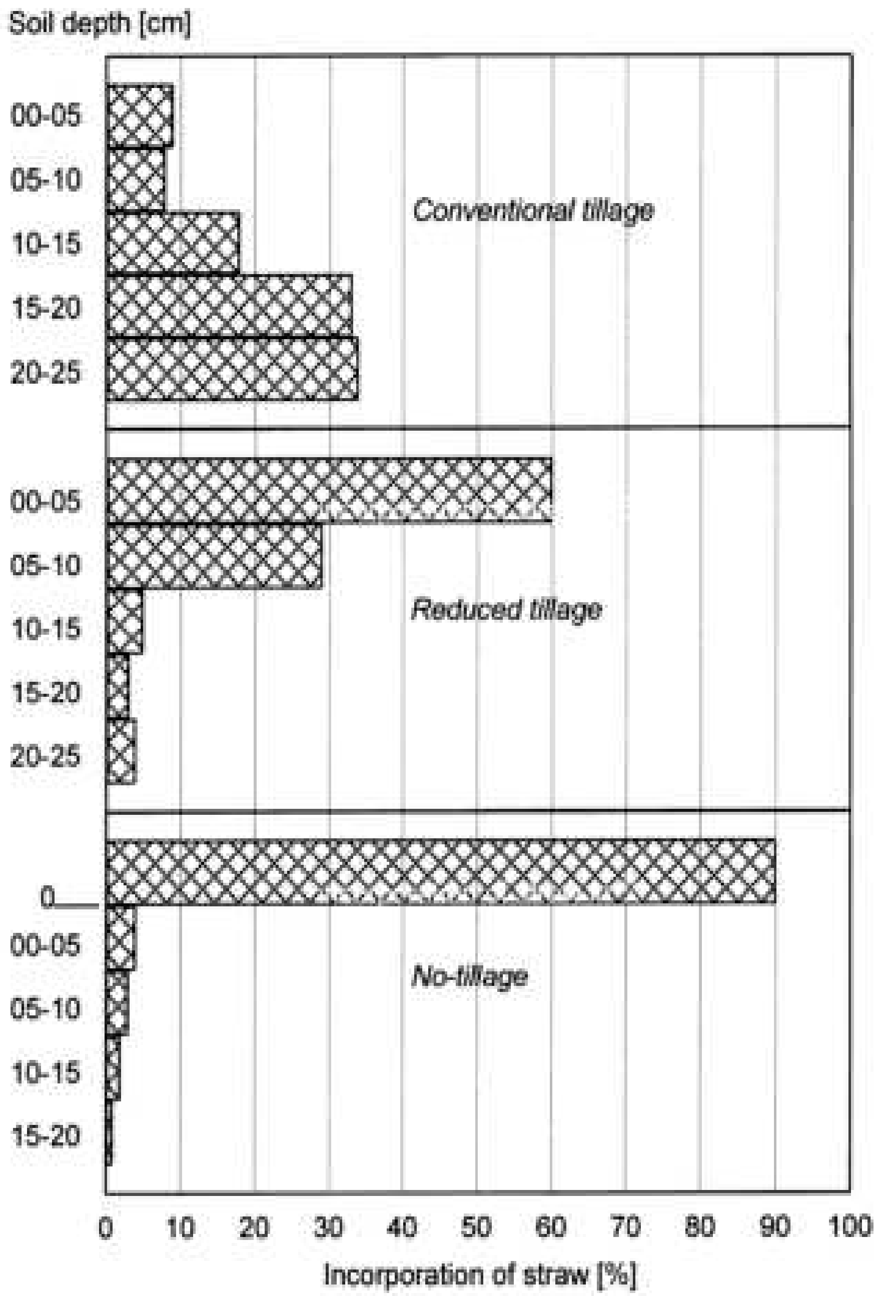


Fig. 4. Degree of incorporation of straw [%] in the soil horizon as affected by soil tillage systems (Schmidt and Tebrügge, 1989).

Periodická orba

Například i dočasné TP na orné půdě jeteloviny etc.

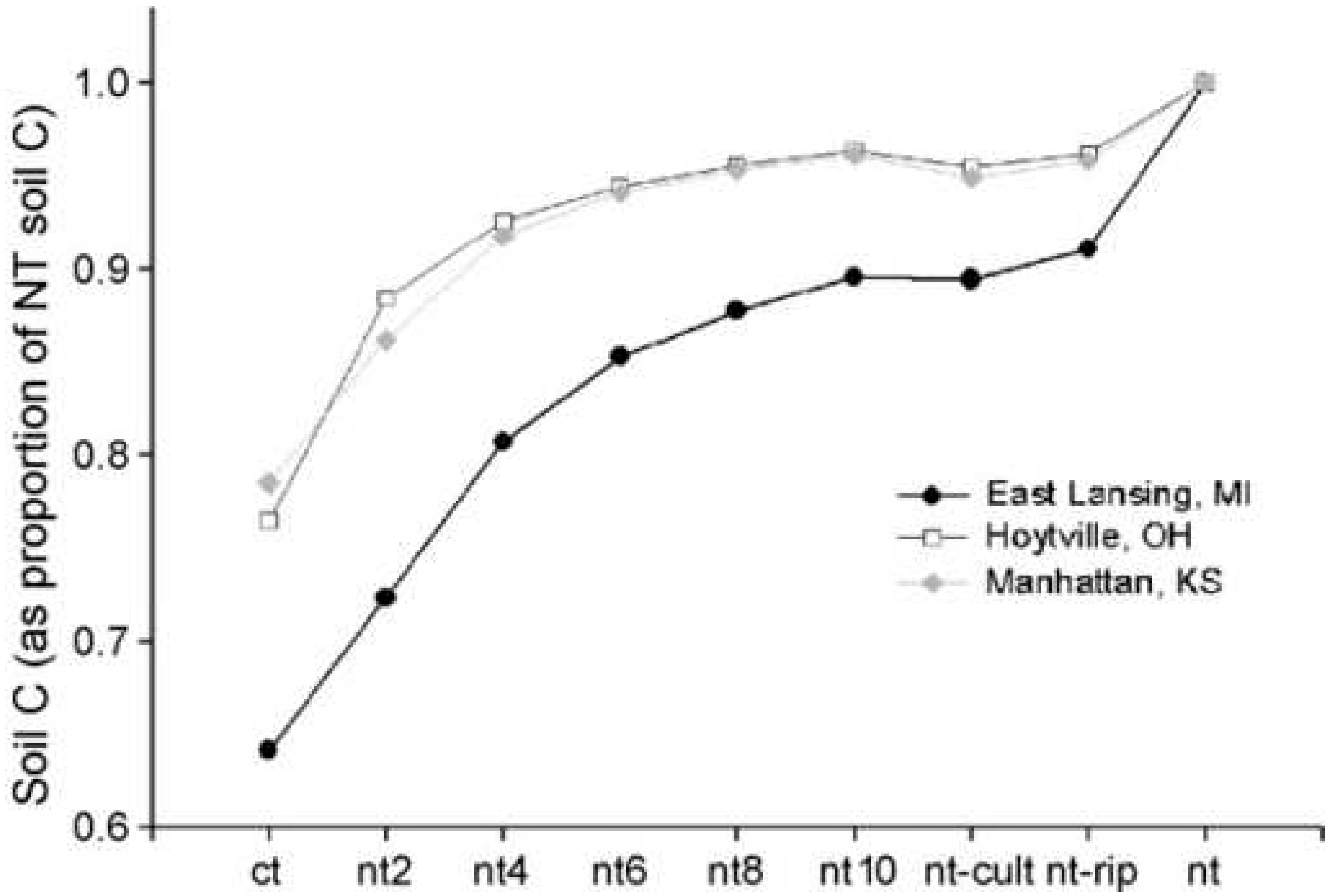


Fig. 2. Proportional reductions in soil C stocks (relative to long-term NT) for three sites: East Lansing, MI; Hoytville, OH and Manhattan, KS. Data are from Century model output.

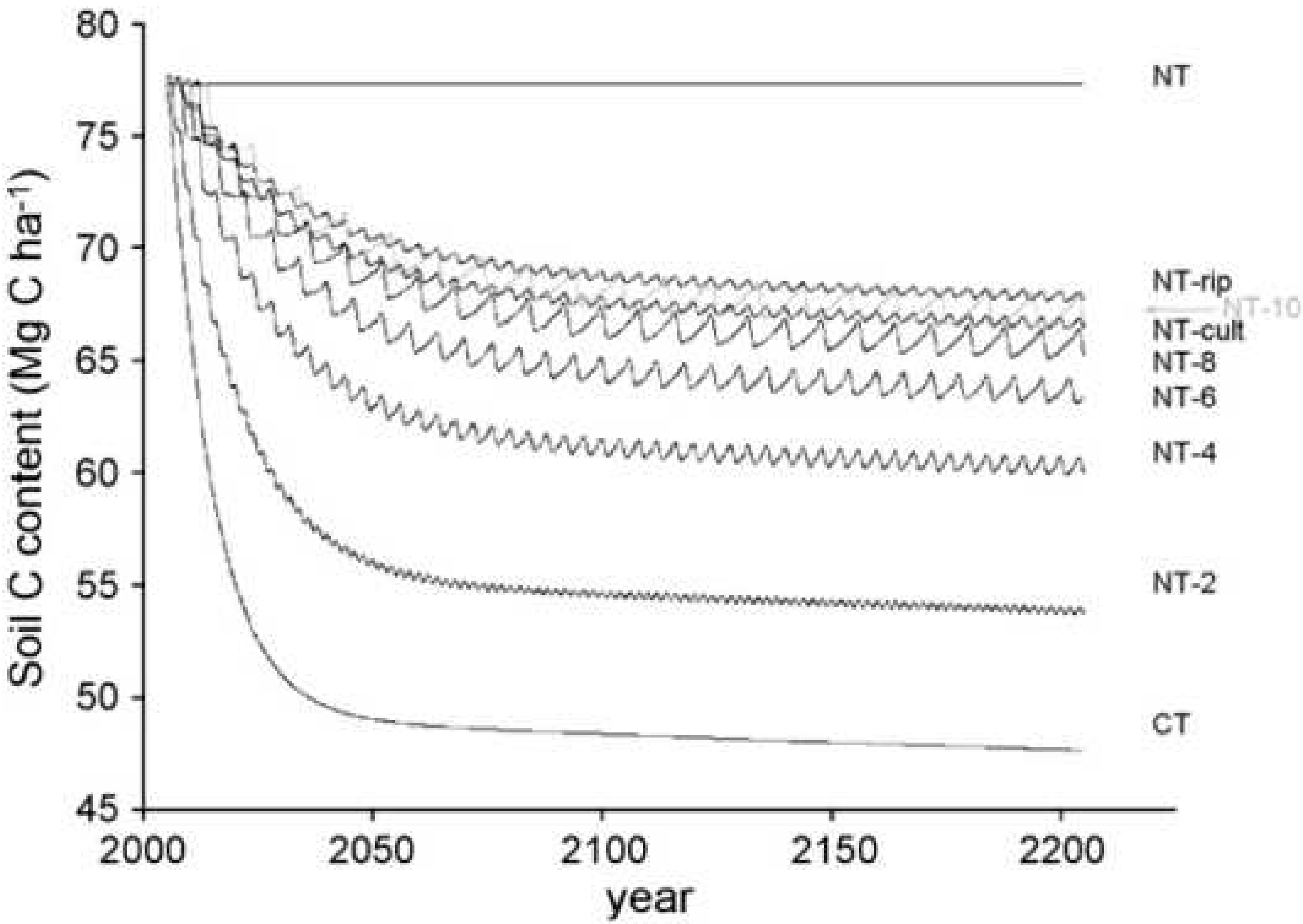
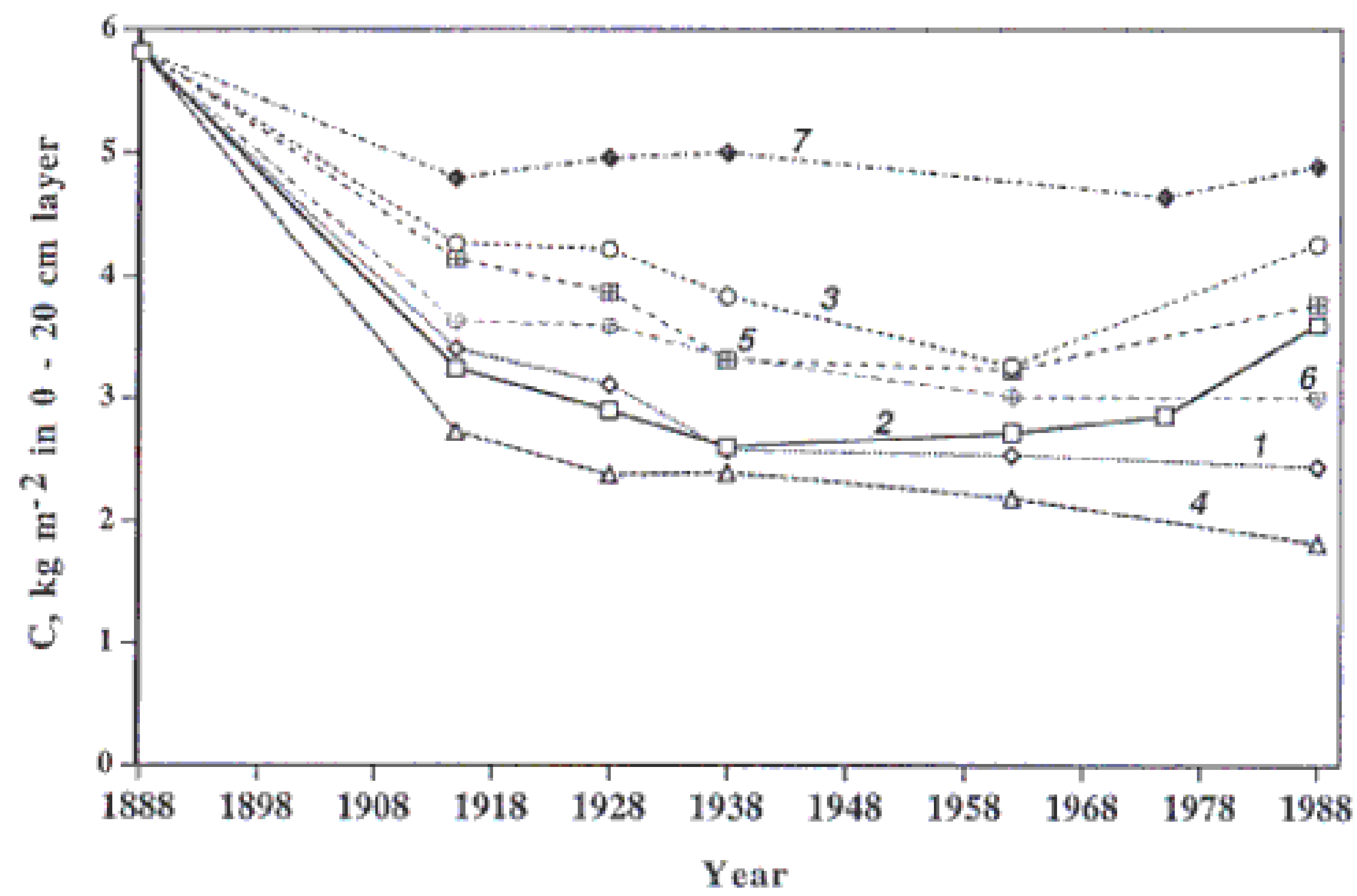


Fig. 3. Century model output illustrating changes in soil C stocks over time and steady-state soil C stocks for different tillage operations and frequencies at East Lansing, MI.

Přísun organické hmoty

Dynamika půdní organické hmoty písčítá půda, Missouri, (1) pšenice (2) pšenice min hnojení; (3) pšenice min hnojení hnůj 12t ha; (4) kukuřice; (5) kukuřice min hnojení hnůj 12t ha; (6) travina (7) travina min hnojení hnůj 12t ha.

G. Buyanovsky and G. Wagner, 1998. "Carbon cycling in cultivated land and its global significance." Global Change Biology 4:131–141.



Shrnutí

- Organická hmota půdy hraje významnou roli v koloběhu uhlíku ale i v lokálních ekologických procesech
- akumulace organické hmoty závisí na množství OH vstupujícím do půdy a na jejím zpracování půdními organismy.
- Technologie, které přinášejí více OH a více spoléhají na činnost půdních organismů mohou akumulovat více OH v půdě