Soil Biota Extinction in the Czech Republic

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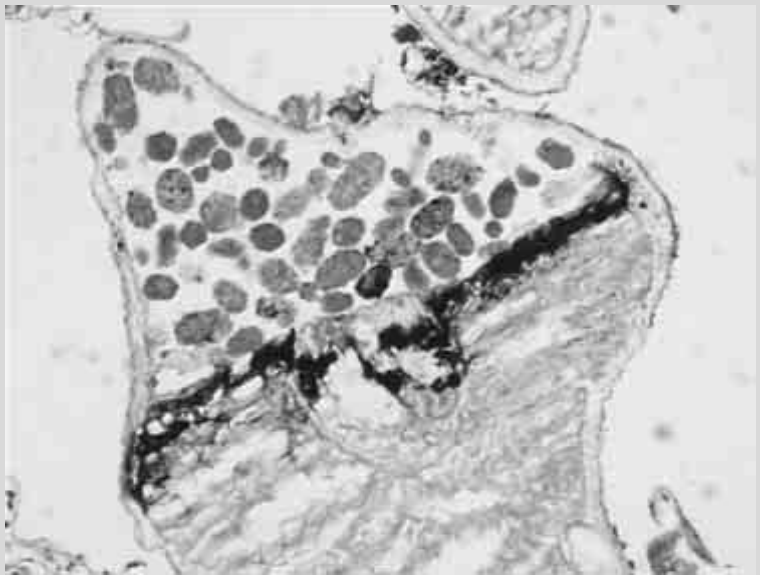
1. Introduction

- **Soil organisms are most important factor in soil formation. There exist direct relation between soil fertility and soil biota diversity. Soil without life is no longer a soil (Rusek 1987).**

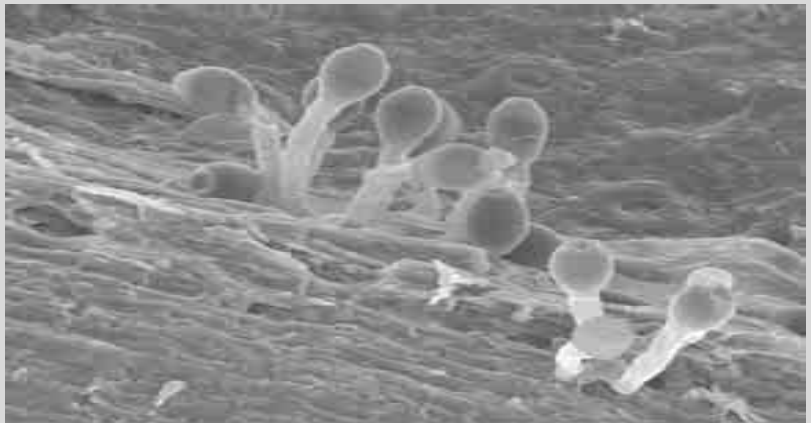
• Soil biota are the engine of decomposition processes, nutrient cycling, humus and soil microstructure formation. During the succession is diversified not only the soil biota community structure but also its functional role (e.g. soil horizons formation).

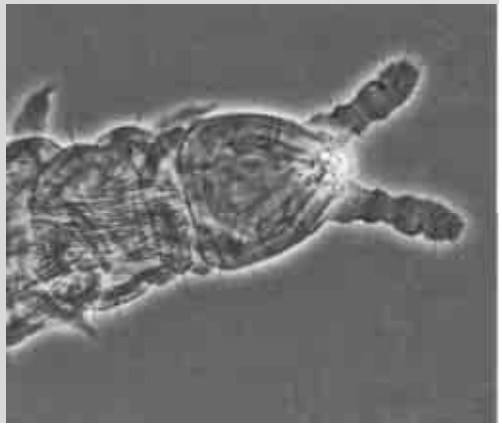


2. Human impact on soil biota

- **Agriculture generally has a negative impact on soil organisms. Comparing arable soils with the forest and grassland ones, the absence of some ecological groups of soil biota is conspicuous. Lower density and species diversity are typical for arable soils. Intensive industrial farming using high doses of pesticides and fertilizers have a drastic negative impact on soil organisms and chemical processes in soil.**

- **Changes in the composition and dynamics of soil organisms provoke a number of negative reactions in dynamics of chemical processes in soil leading to changes in humus quality and quantity, leaching of P, N, and other nutrients from soil. A podsolization process starts when herbicides are applied for more than four years. Herbicides have a negative impact on the immunity system of soil animals.**



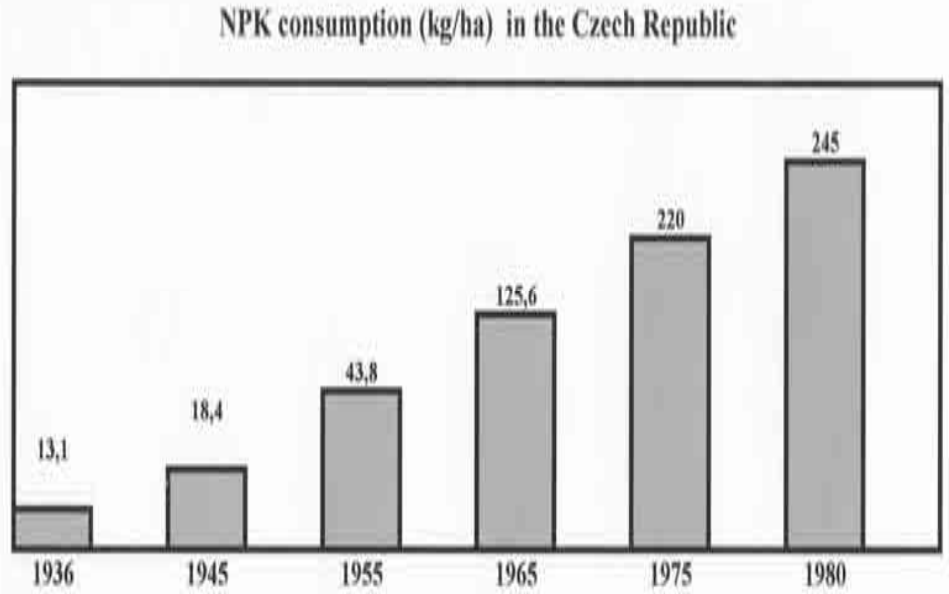


2. Human impact on soil biota

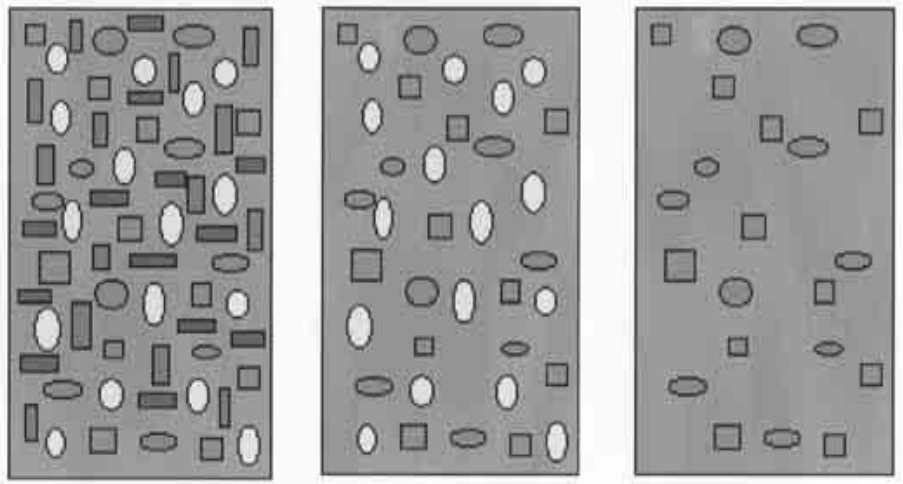
•Soil biota are influenced also by acid precipitation, heavy metals, NO_x deposits and global changes.

•Soil biota are negatively influenced by different management practices,

e.g. forest clear-cutting, fertilizing, and liming of acid soils.



Soil fauna reaction after acidification & liming:

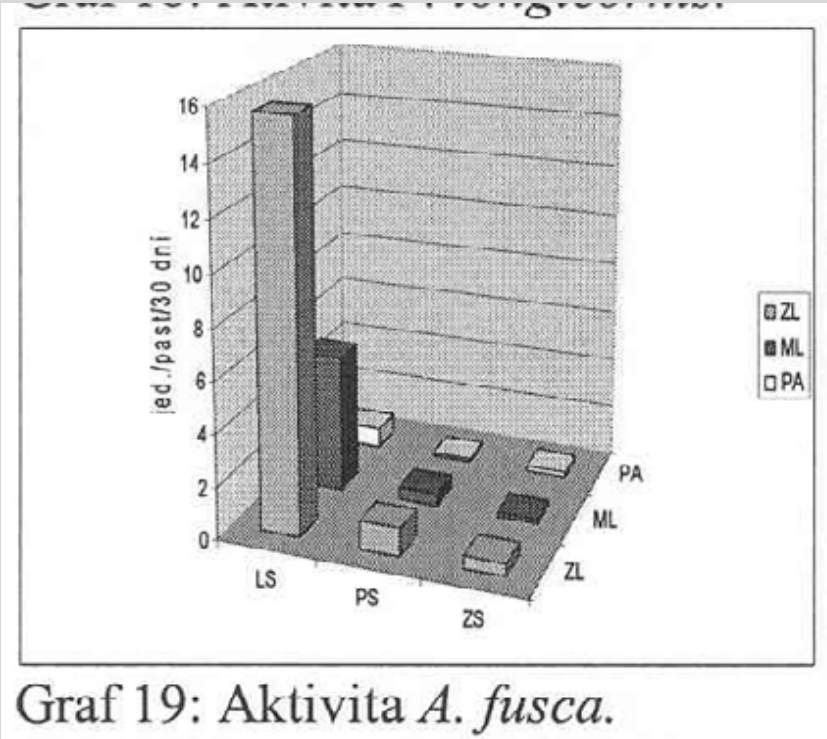


a) normal b) acid rain c) liming

2. Human impact on soil biota

•Clearings have a negative impact on soil fauna. Many endemic and functionally important groups die off, e.g. Protura, Pauropoda, here.

•Some forest epigeic species decline their density and activity in dead forests and die off on the clearings. Widespread grassland species colonize these new habitats with extreme microclimate.



Graf 19: Aktivita *A. fusca*.

3. Damaged and dead soils in the Czech Republic

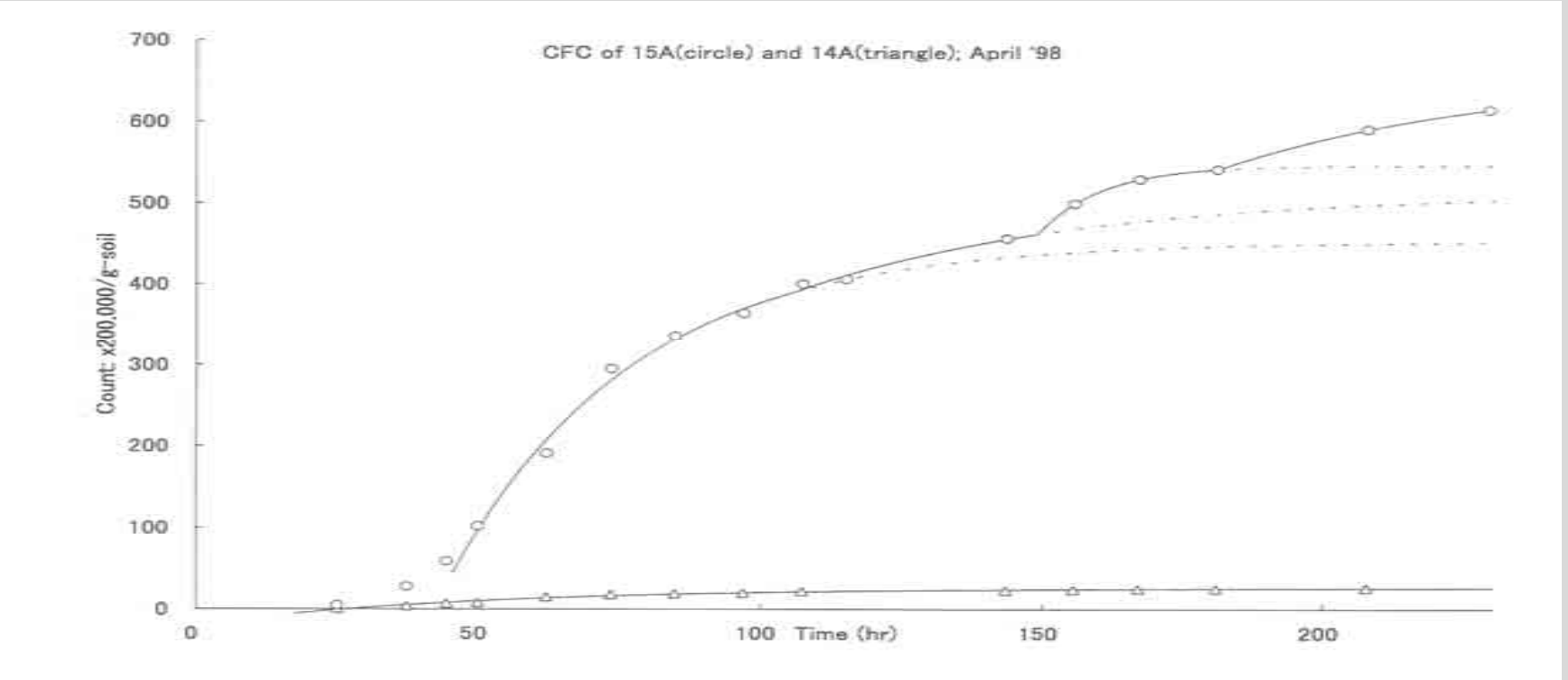
- **In the first half of the 1960s very high densities and species richness of soil mesofauna communities were recorded in the arable soils in S. Moravia and S. Slovakia. Collembolan community densities reaching 40,600 to 139,600 individuals per m^2 consisted of 28 to 34 species. The total micro-arthropod densities reached no fewer than almost one million individuals. Even such specialised and fragile groups like Protura, Pauropoda, Symphyla or Diplura were living in the arable soils (Rusek 2000).**

Densities (ind.m^{-2}) of Collembola and other microarthopods in maize field at Palárikovo

Soil horizon	0 - 10 cm	10 - 20 cm	20 - 30 cm	∑
Collembola	118 600	21 000	0	139 600
Oribatida	366 100	41 200	100	407 400
Prostigmata	257 000	22 200	100	279 300
Mesoostigmata	82 400	29 500	100	112 000
Pauropoda	5 800	5 300	0	11 100
Protura	0	300	0	300
∑	829 900	119 500	300	949 700

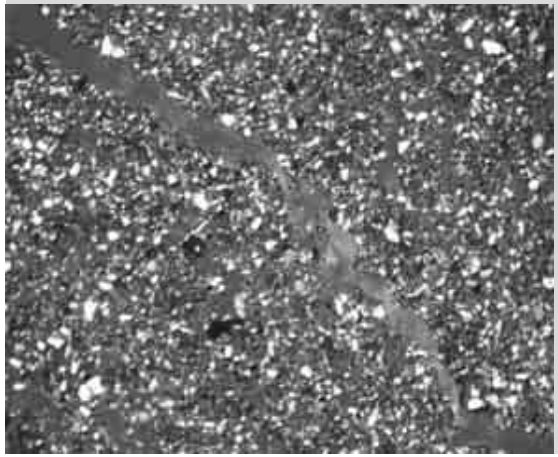
3. Damaged and dead soils in the Czech Republic

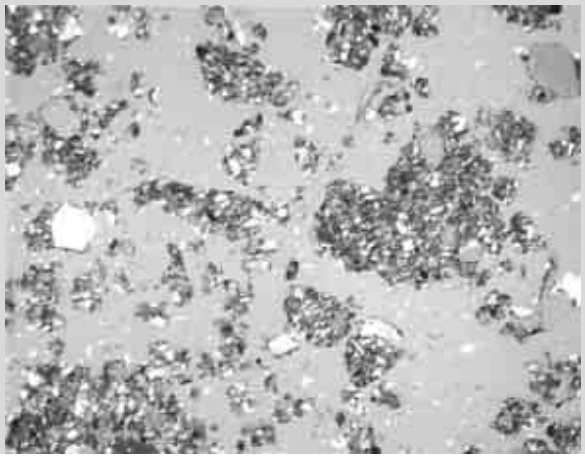
- **Three years later, in 1967, a complete collapse of these rich soil animal communities was recorded on the same plots. The density decreased drastically to 800 – 4,200 individuals per m^2, and only 4-5 collembolan species remained from the former species rich communities! These low community parameters, acompanied by low soil bacterial densities (Hattori & Rusek, ms) and the extinction of anecic earthworms and other groups of soil macrofauna, still persist there today!**

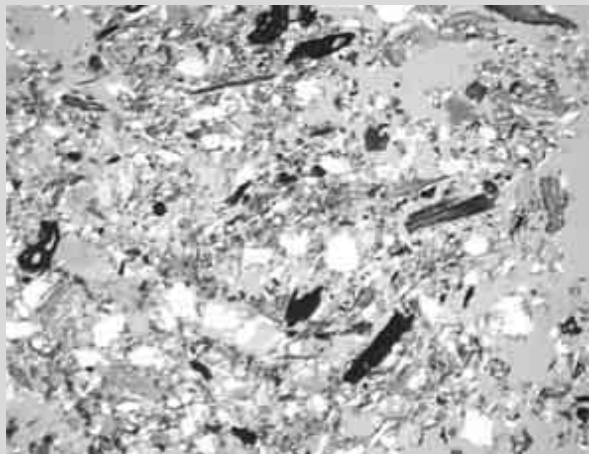


3. Damaged and dead soils in the Czech Republic

- **Recent investigations in northern Austria adjacent to our arable plots in southern Moravia have indicated better soil biological parameters on some farms with ecological management there (Uteseny 2003, Rusek unpblished data). The different, industrial type of agriculture led to a high extinction rate of soil biota in our country and to almost dead soils. Such soils will occur in most of the former East European countries with state industrial type of agriculture, but also in the western countries have been established arable plots with almost dead soils!**
- **The extinction of functionally important soil biota led to soil compaction because of the lack of anecic earthworms restoring the soil microstructure each year. Their deep burrows contribute to soil aeration, to rain water and root penetration into deeper soil horizons.**







3. Damaged and dead soils in the Czech Republic

•Organic-mineral complexes and the mull humus form are not produces in the absence of these anecic earthworms, so the soil microstructure gradually collapses and a dense compacted soil is formed. Soil micro-arthropods do not activate the soil micro-flora and the decomposition of dead organic matter is severely retarded or even stopped. Many soil-borne plant diseases are not eliminated in the absence of specific soil microarthropods and they are widespread in such fields, e.g. potato scab (*Streptomyces scabiae*).

4. Discussion

- **Investigations done in decades after 1970 have shown that the collembolan densities in arable soils in different parts of the Czech Republic were reaching 800 – 36,400 individuals per m^2, and comprised 3 – 21 species. Arable soils were grouped according the collembolan density (D) and species number (S) into:**

1. undisturbed (D>20,000 ind.m^2, S>20 spp.),
2. moderately damaged (D>10,000 ind.m^2, S>10 spp.), and
3. heavily damaged (D<10,000 ind.m^2, S<10 spp.) (Rusek 2003).

Loc.	Year	Ind.m2	Spp. No.
S.Moravia	1964	40 600 - 62 200	34
	1967	800- 4 200	4 - 5
	1990	800 - 4 100	4 - 5
S.Slovakia	1964	139 600	28
Mořina	1977	36 400	21
Hrnčíře	1974	2 500 - 25 600	6 - 17
Troubsko	1974	8 100 - 26 900	12 - 13
Lahošť	1992	16 400	17
Nezamyslice	1992	9 000	12
Nitra	1985	7 000	6
Pelhřimov	1986	2 200	3

4. Discussion

• We have elaborated a methodology in the Institute of Soil Biology ASCR to use the soil fauna for bioindication of arable soil quality (Rusek et al. 1993) but problems with the project funding did not allow its realization. We have some data from e.g. NE Moravia, S Bohemia showing that the fields of private owners have better soil biological quality than the former state owner farms.

•We do not know how large the acreage of the heavily and slightly damaged arable soils is in our country, but it will be very important to analyze this and to use the biological parameters as one of the most important soil characteristics.

•We have information in the Institute of Soil Biology on how fast the recovery of moderately damaged small abandoned field plots is during secondary succession, but we do not know how fast will be the recovery of soil biota communities in huge areas of arable fields established during the industrial type of agriculture in the 1950s and 1960s.

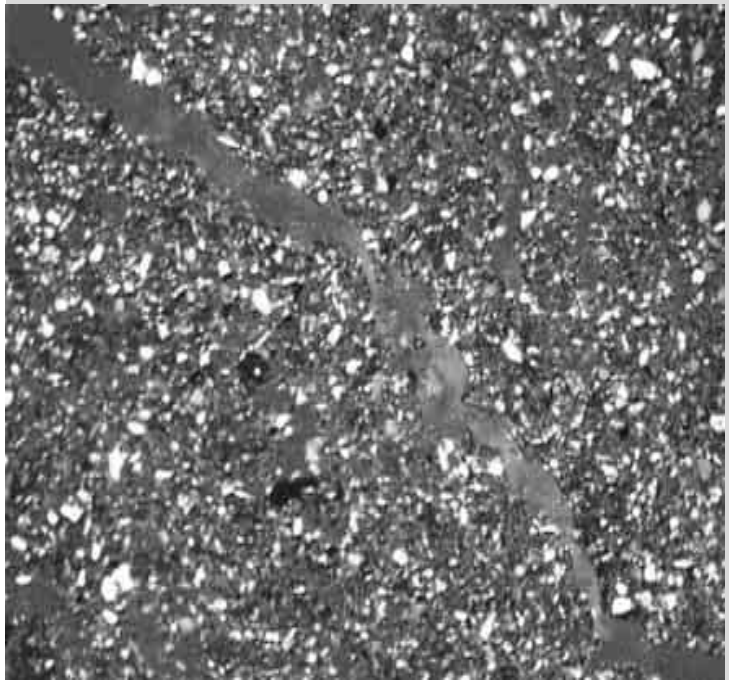
•We and all the EU countries need basic data concerning the soil biological parameters of arable land to accept decisions for improvement of moderately and heavily damaged soils.

4. Discussion

• Soil biological parameters should be used for monitoring the arable soil quality and for improving the management practices.

• Biological parameters in forest soils reach only exceptionally the stage of *moderately damaged* in our country.

•The high damaged dead soils are connected also with very low humus content like the chernozems in south Moravia (Fig.). The management of such arable soils should be controlled by prescribed steps improving the humus content and soil biota restoration.



5. Conclusion and recommendations

• Extinction of soil biota was documented for arable soils in different districts of the Czech Republic. The acreage of moderately and heavily (dead) damaged soils is not yet known.

•The biologically degraded soils are connected with soil compaction, humus content decrease, pesticide residues, heavy metal content and other negative properties.

•Monitoring of soil biota with high bioindicator values should be realized in the Czech Republic and EU countries.

•To propose methods for increasing biota density and biodiversity in arable soils.

•To use soil biological parameters as important indicators for management practice on differently damaged soils.