EKOSYSTÉMOVÉ SLUŽBY EXTENZIVNĚ OBHOSPODAŘOVANÝCH TRAVNÍCH POROSTŮ V HORSKÝCH A PODHORSKÝCH OBLASTECH

Diskriminace ekosystémových služeb průmyslovými hnojivy

Ing. Jaroslav Záhora, CSc., MENDELU Brno

Mendelova univerzita v Brně
BIOINSTITUT
Agronomická fakulta
SONDAR CZ-AT
Soil Strategy Network in the Danube Region
EUROPEAN UNION
European Regional Development Fund
SPOLUPRÁCE CZ - KOOPERATION AT
EUROPEAN TERRITORIAL CO-OPERATION
AUSTRIA-CZECH REPUBLIC 2007-2013
Gemeinsam mehr erreichen. Společně dosáhneme více.

Organické zemědělství Konvenční zemědělství

Provzdušnělá půda

Utužená půda

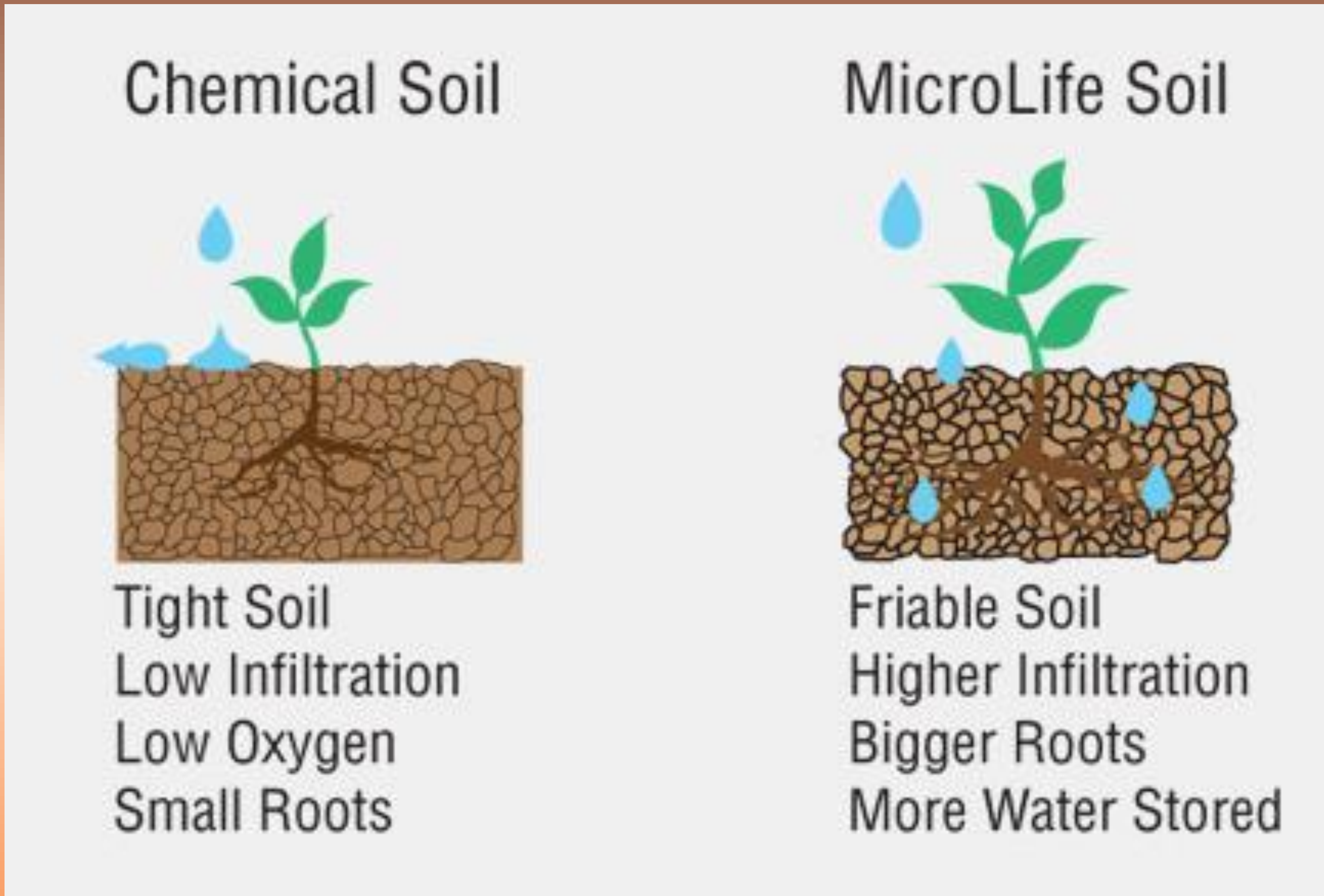
Větší infiltrace

Malá infiltrace

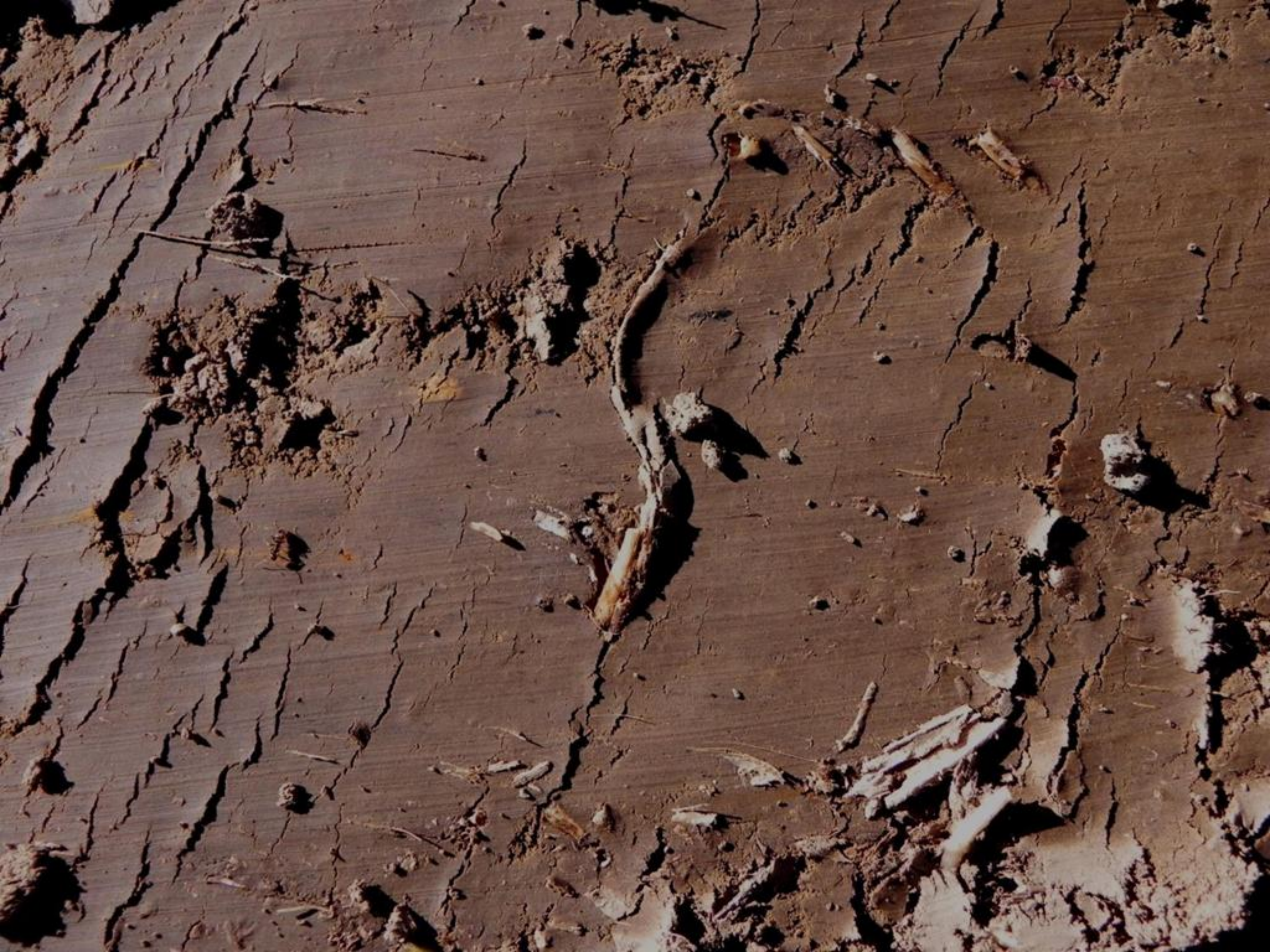
Více kořenů

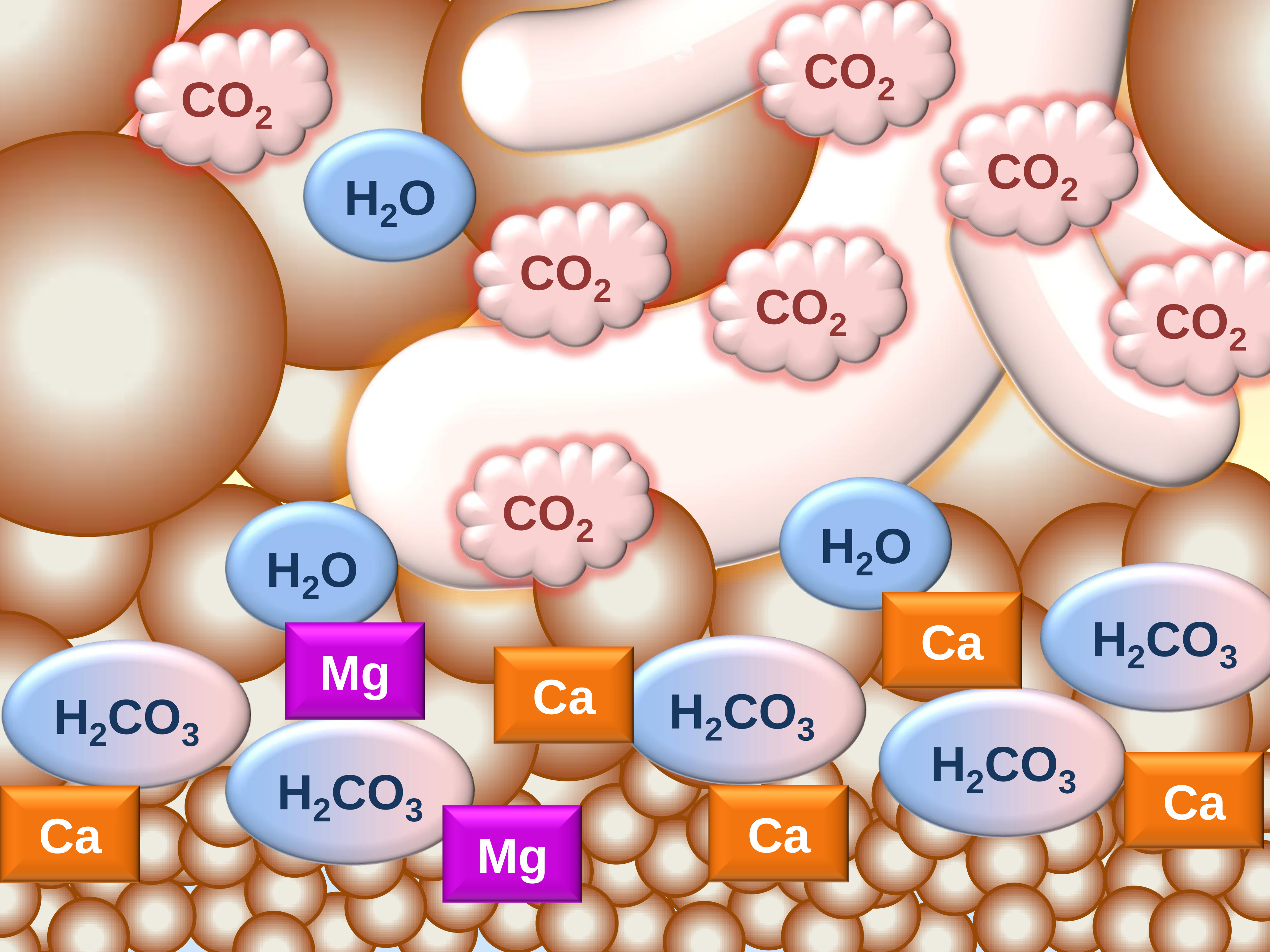
Málo kyslíku

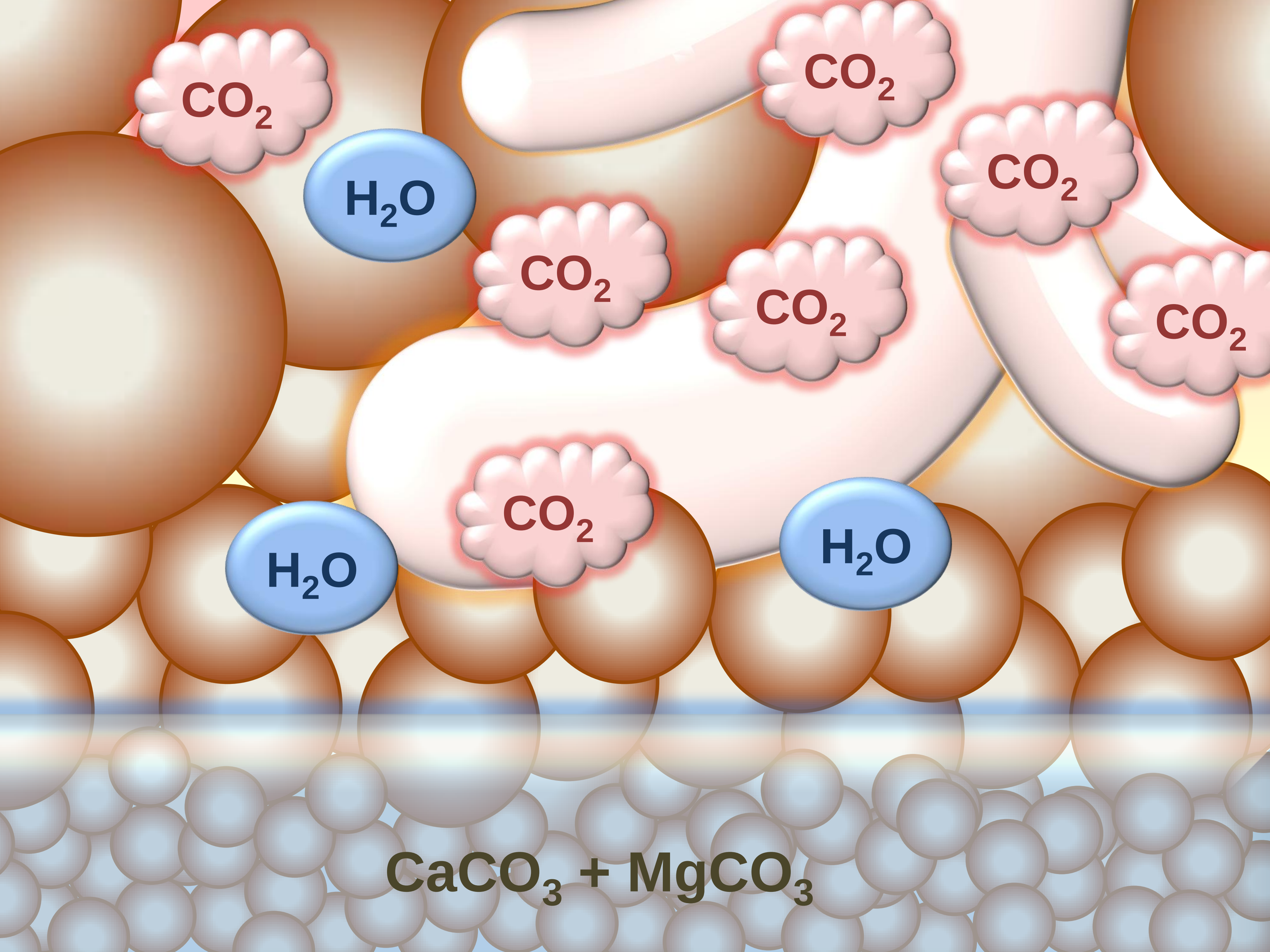
https://www.amazon.com/Fertilizer-Multi-Purpose-Vegetables-Professional-MicroLife/dp/B06XJLQ435


Chemical Soil
MicroLife Soil
Tight Soil
Low Infiltration
Low Oxygen
Small Roots
Friable Soil
Higher Infiltration
Bigger Roots
More Water Stored

živa 2/2015

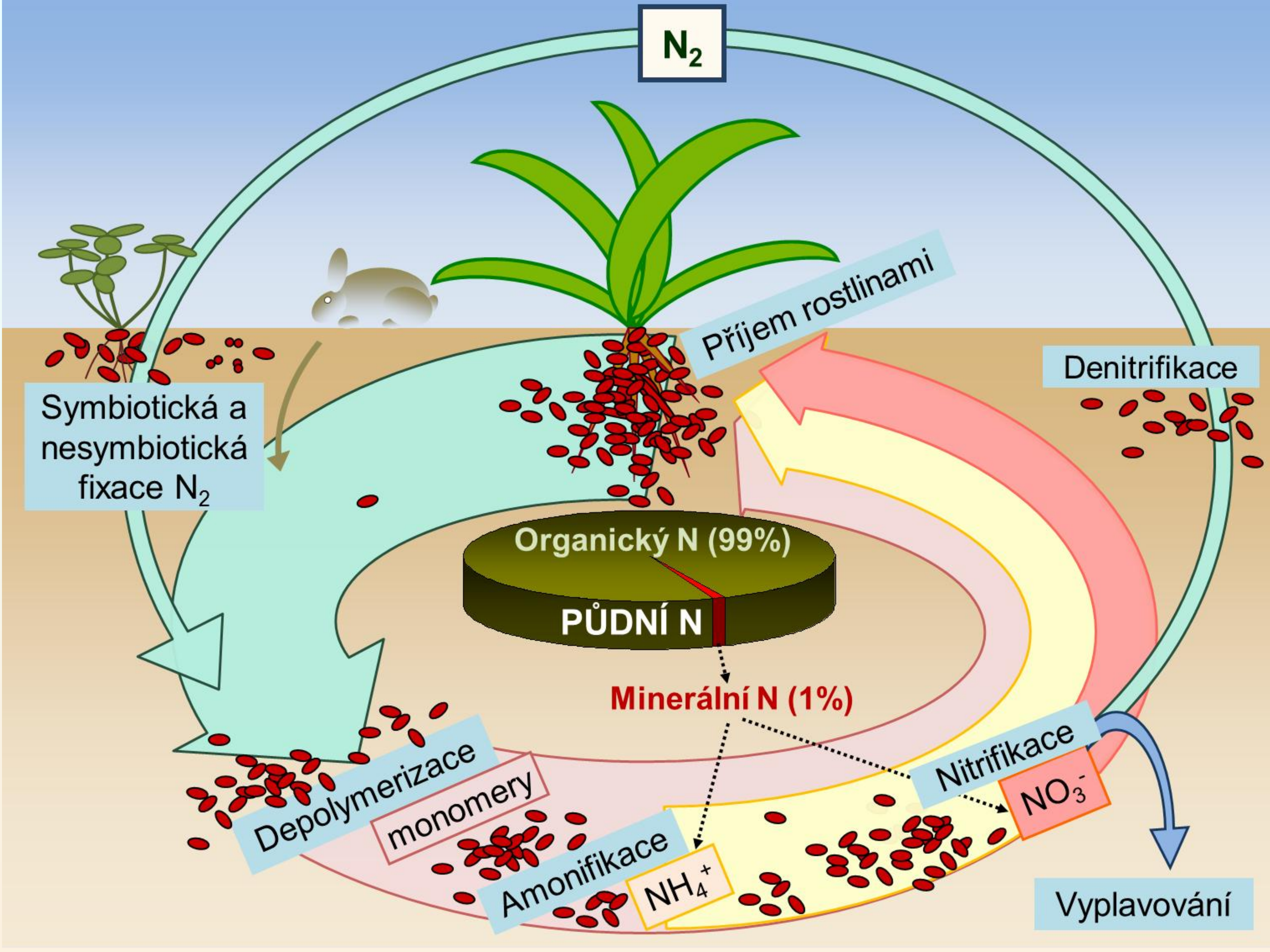



CO_2
CO_2
CO_2
H_2O
CO_2
CO_2
CO_2
CO_2
H_2O
H_2O
Mg
Ca
Ca
H_2CO_3
H_2CO_3
H_2CO_3
H_2CO_3
H_2CO_3
Ca
Ca
Mg
Ca

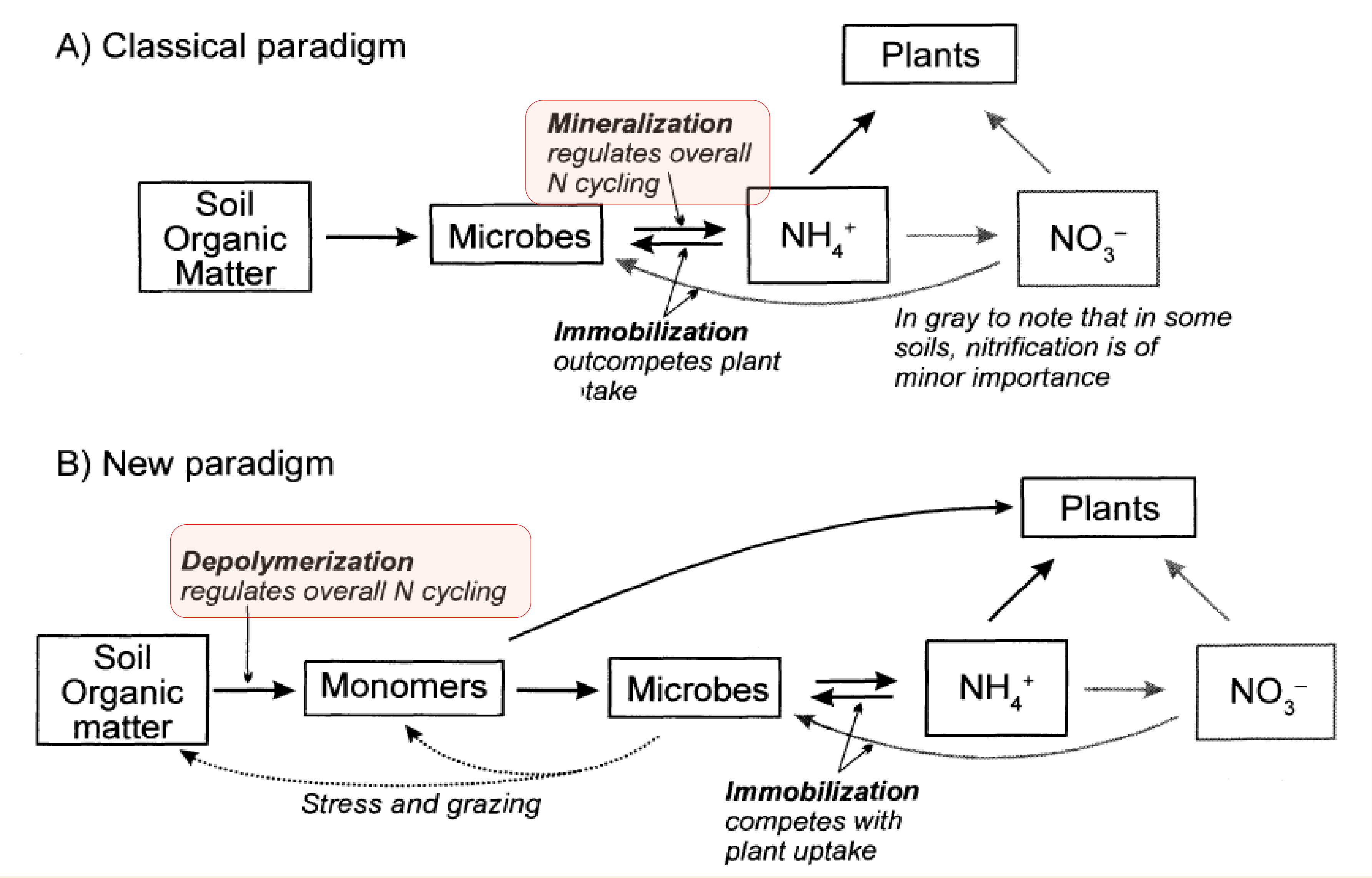

CO_2
CO_2
CO_2
CO_2
CO_2
CO_2
CO_2
H_2O
H_2O
H_2O
$CaCO_3 + MgCO_3$

Biologická degradace vede ke zhutnění povrchu půdního podorničí


Xanthoria
parietina



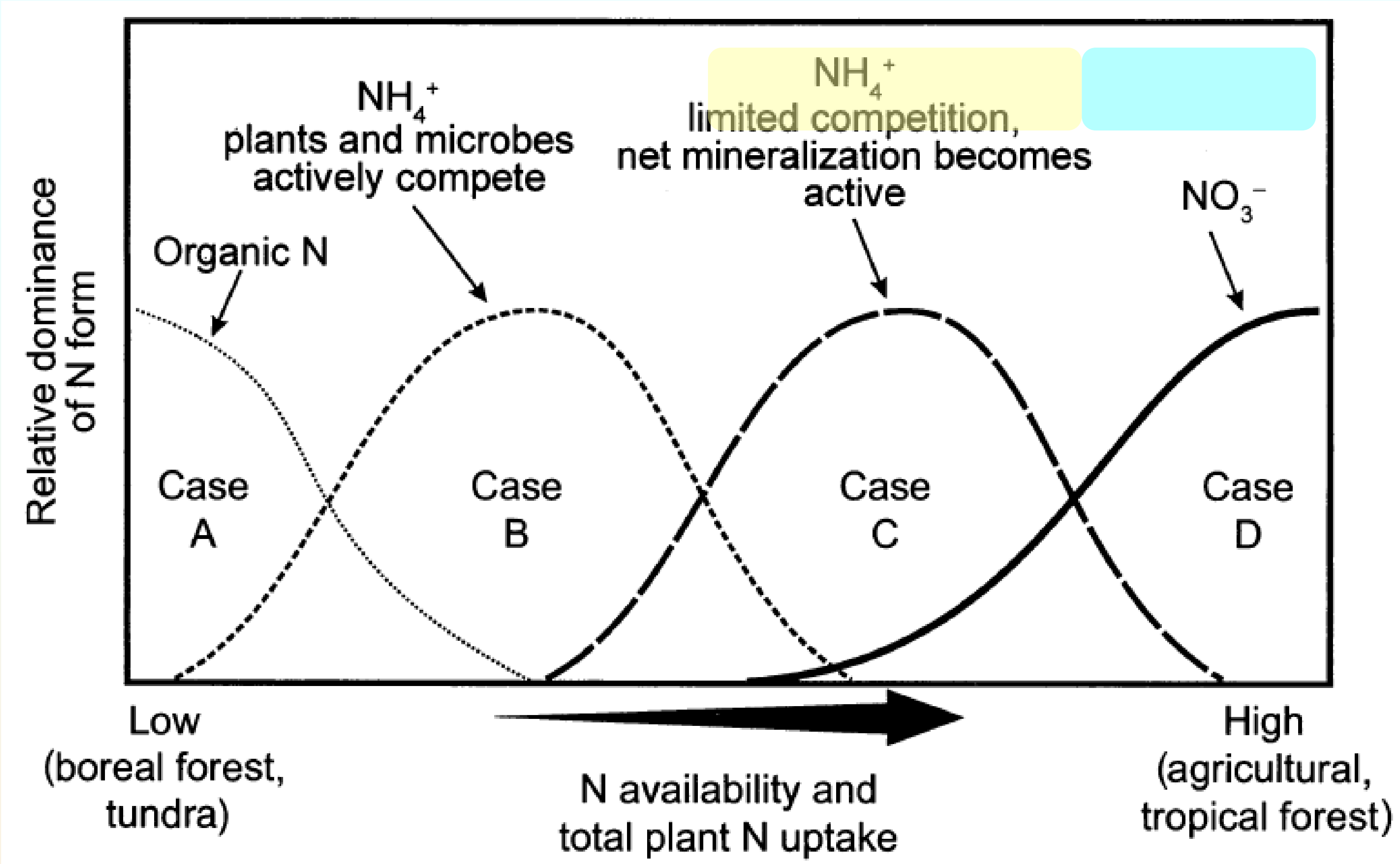
N_2
Příjem rostlinami
Denitrifikace
Symbiotická a nesymbiotická fixace N_2
Organický N (99%)
PŮDNÍ N
Minerální N (1%)
Depolymerizace
monomery
Amonifikace
NH_4^+
Nitrifikace
NO_3^-
Vyplavování



(Schimel et Bennett, 2004)

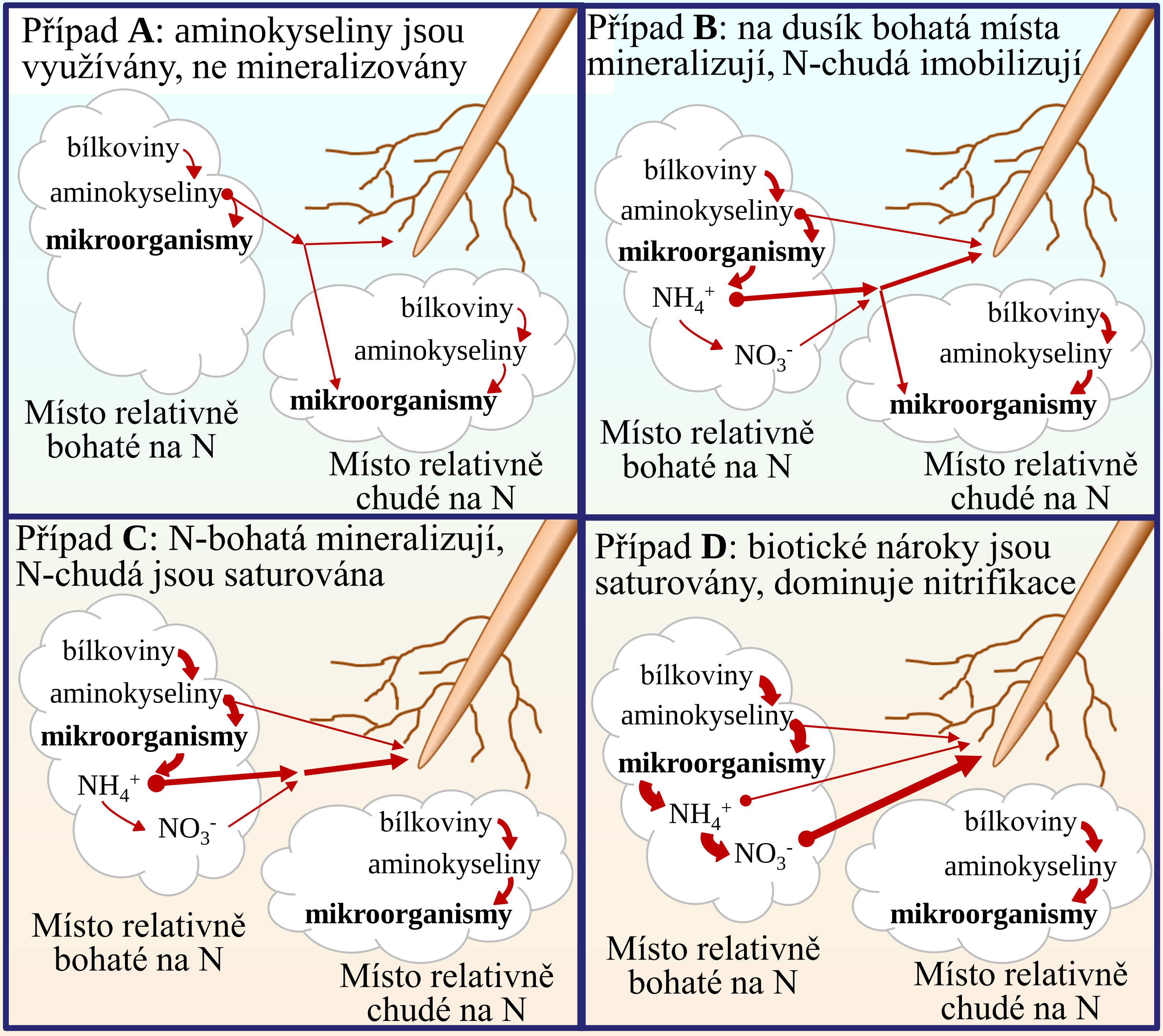
The changing paradigm of the soil N cycle.

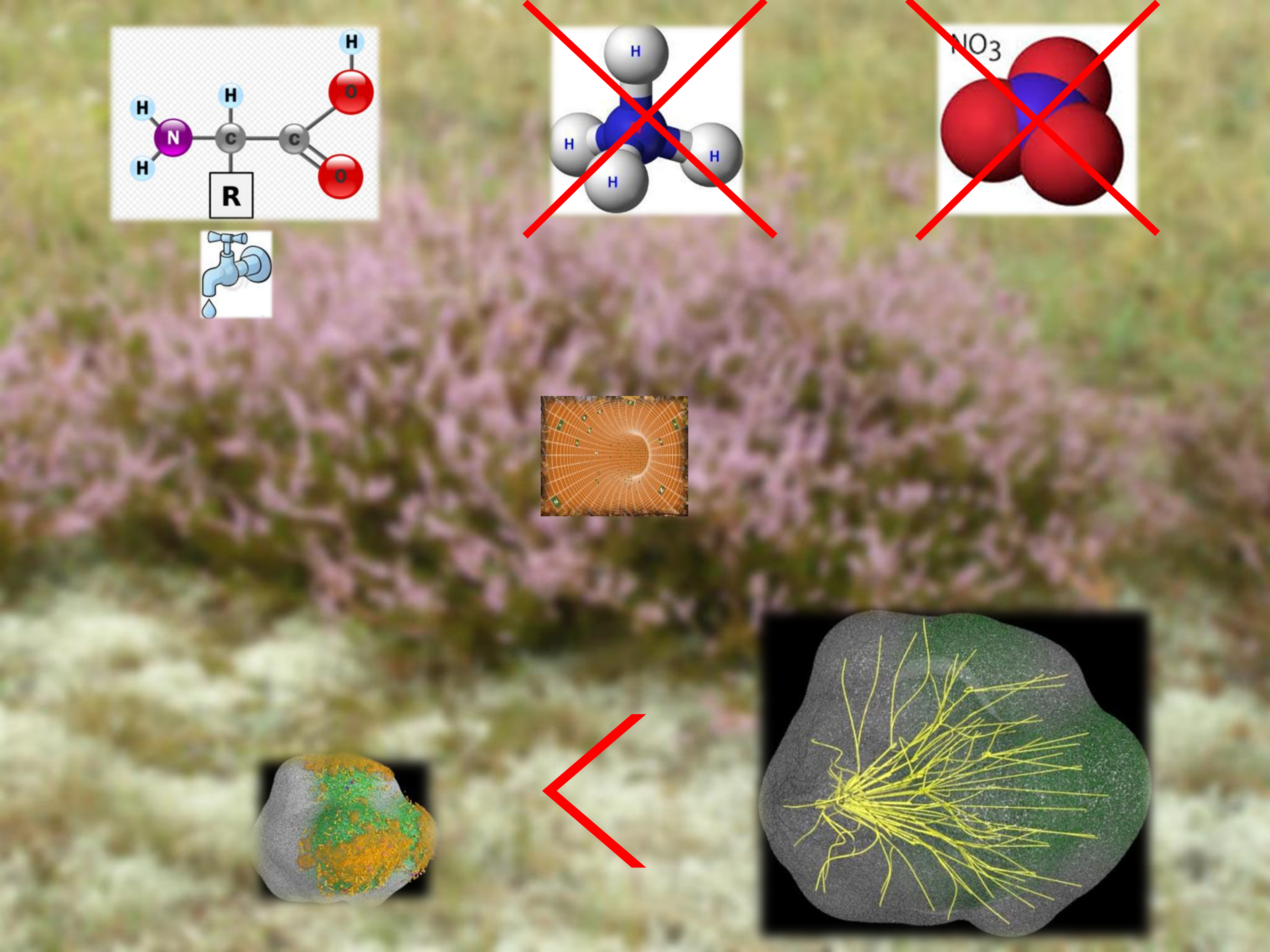
N cycling is now seen as being driven by the depolymerization of N-containing polymers by microbial extracellular enzymes.



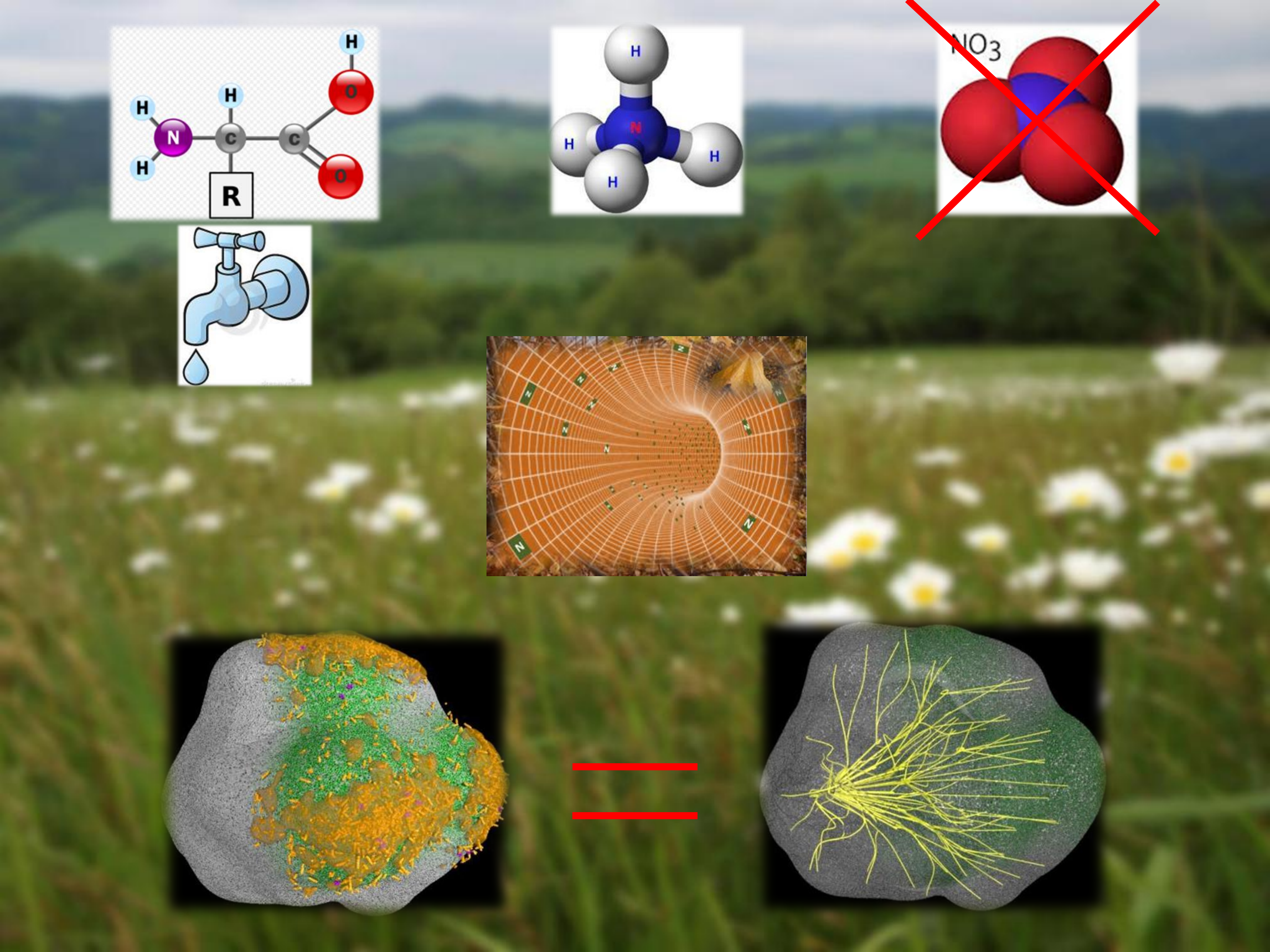
(Schimel et Bennett, 2004)

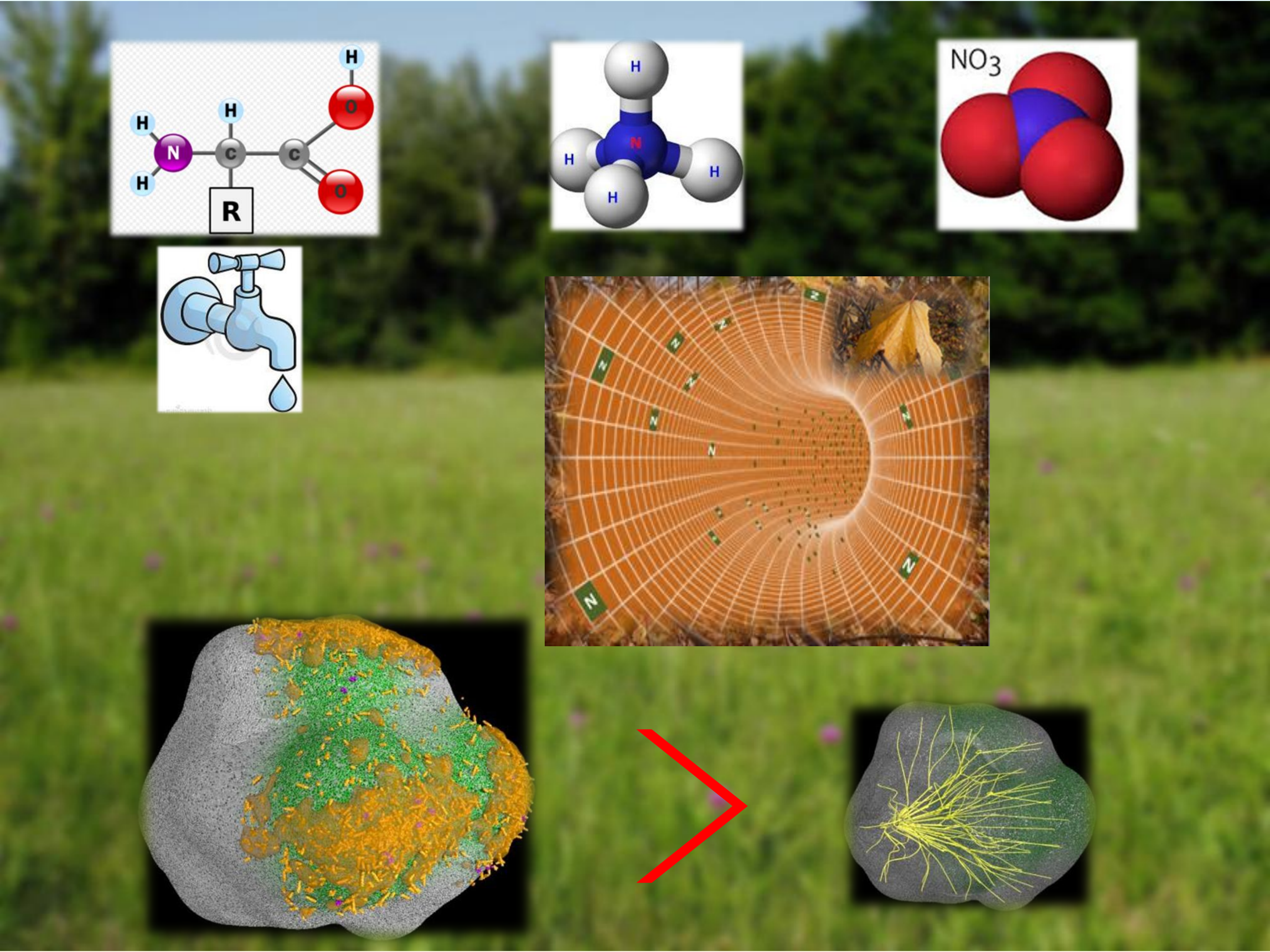
If we were able to capture an excess of NH_4^+ and NO_3^- ions from soil solution, then we will be able to assess at what stage is the current N-load of the alpine ecosystem.

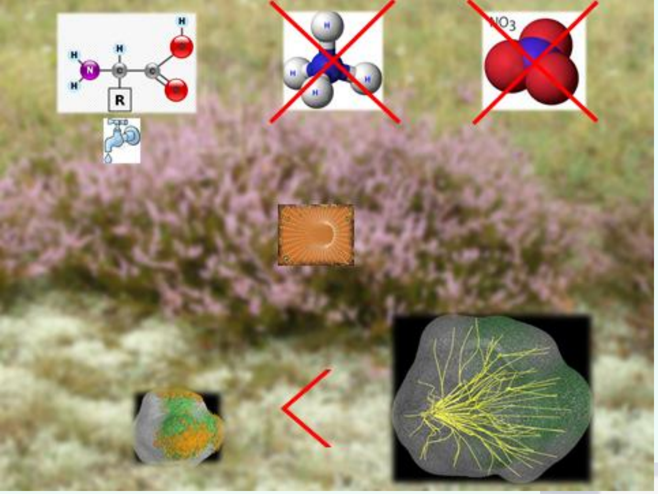

Případ A: aminokyseliny jsou využívány, ne mineralizovány
bílkoviny
aminokyseliny
mikroorganismy
Místo relativně bohaté na N
bílkoviny
aminokyseliny
mikroorganismy
Místo relativně chudé na N
Případ B: na dusík bohatá místa mineralizují, N-chudá imobilizují
bílkoviny
aminokyseliny
mikroorganismy
NH4+
NO3-
Místo relativně bohaté na N
bílkoviny
aminokyseliny
mikroorganismy
Místo relativně chudé na N
Případ C: N-bohatá mineralizují, N-chudá jsou saturována
bílkoviny
aminokyseliny
mikroorganismy
NH4+
NO3-
Místo relativně bohaté na N
bílkoviny
aminokyseliny
mikroorganismy
Místo relativně chudé na N
Případ D: biotické nároky jsou saturovány, dominuje nitrifikace
bílkoviny
aminokyseliny
mikroorganismy
NH4+
NO3-
Místo relativně bohaté na N
bílkoviny
aminokyseliny
mikroorganismy
Místo relativně chudé na N

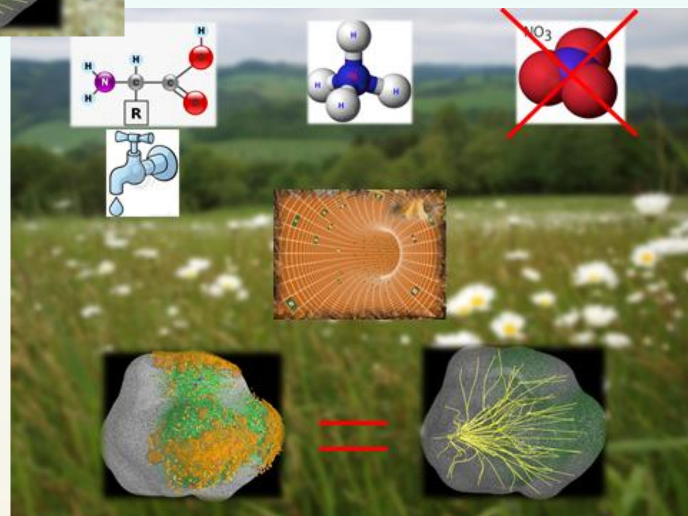


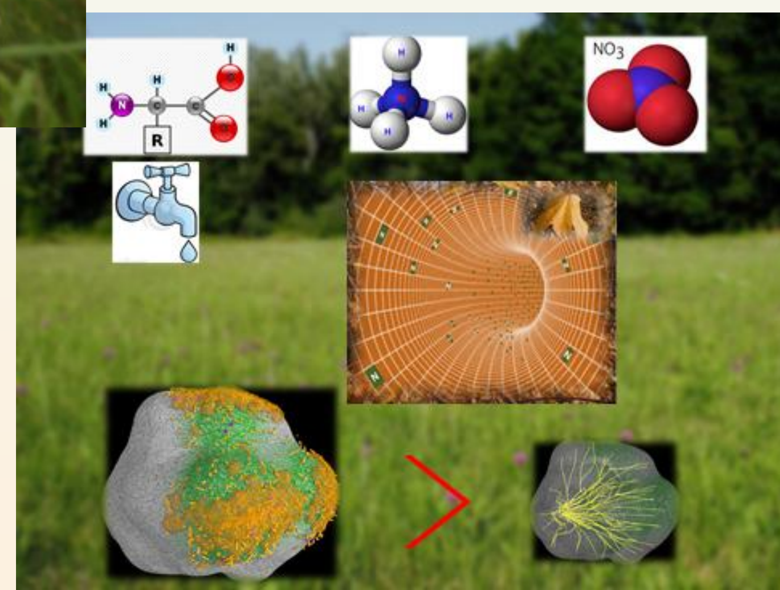
H
H
N
C
C
O
O
R
NO3


H
N
C
O
R
NO3


H
N
C
O
R
NO3


R
NO3


R
NO3


R
NO3

Karl GÖDEL

(6. 9. 1870 Brno – 20. 10. 1948 Vídeň)

Absolvent krajinářské školy prof. E. P. Lichtenfelse na vídeňské Akademii. Žil ve Vídni, velmi často však maloval v plenéru, především na Znojemsku (Podhradí nad Dyjí) a Brněnsku.

Obr. 2. Regenerace vřesu 15 let po odstranění drnu v mozaikovitém porostu vřesoviště a suchého trávníku u obce Havraníky na úbočí kopce Staré vinice (srpen 2007). Foto: Jaroslav Záhora

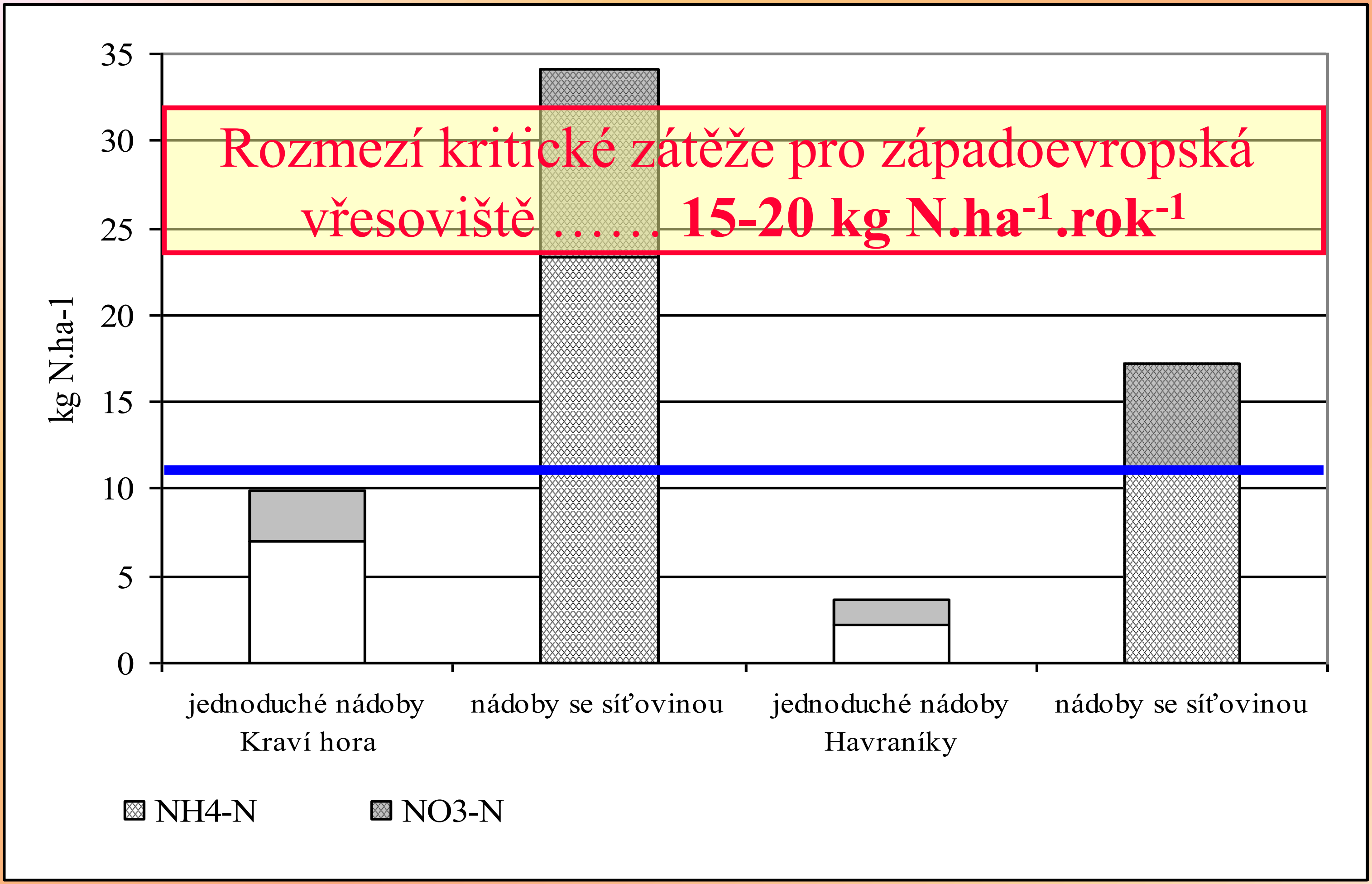
Vysvětlivky: Vyznačena je původní plocha pokusného zásahu 4 x 4 m.

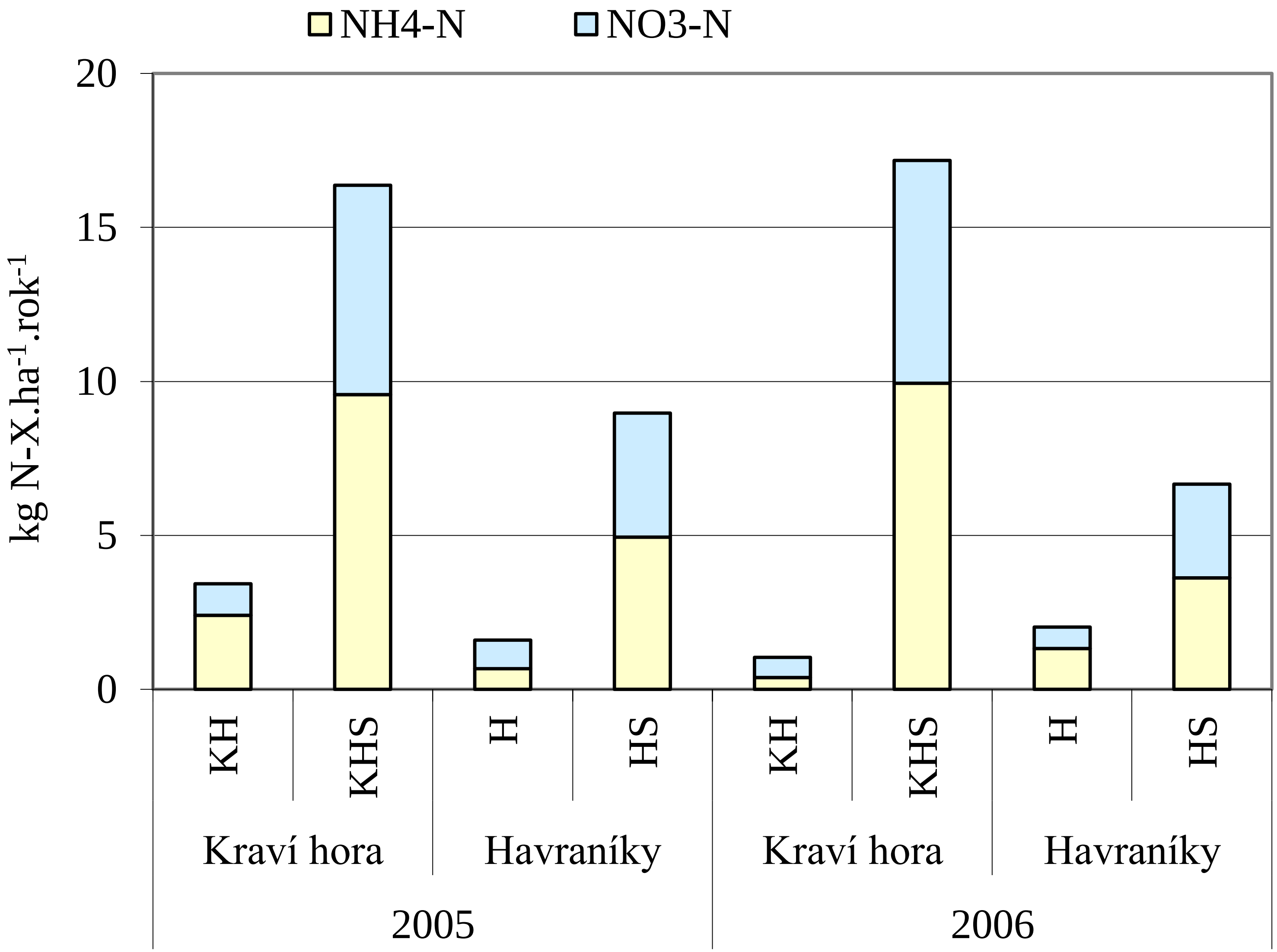
Obr. 3. Zarůstání vřesovišť expanzivní třtinou křovištní (*Calamagrostis epigejos*) u obce Havraníky (srpen 2006). Foto: Jaroslav Záhora

3. Monitorování vstupu dusíku se srážkami

Záchytné nádoby - detail

Kumulativní množství minerálního dusíku zachycené v sběrných nádobách v období od 13. 2. 2002 do 17. 9. 2003



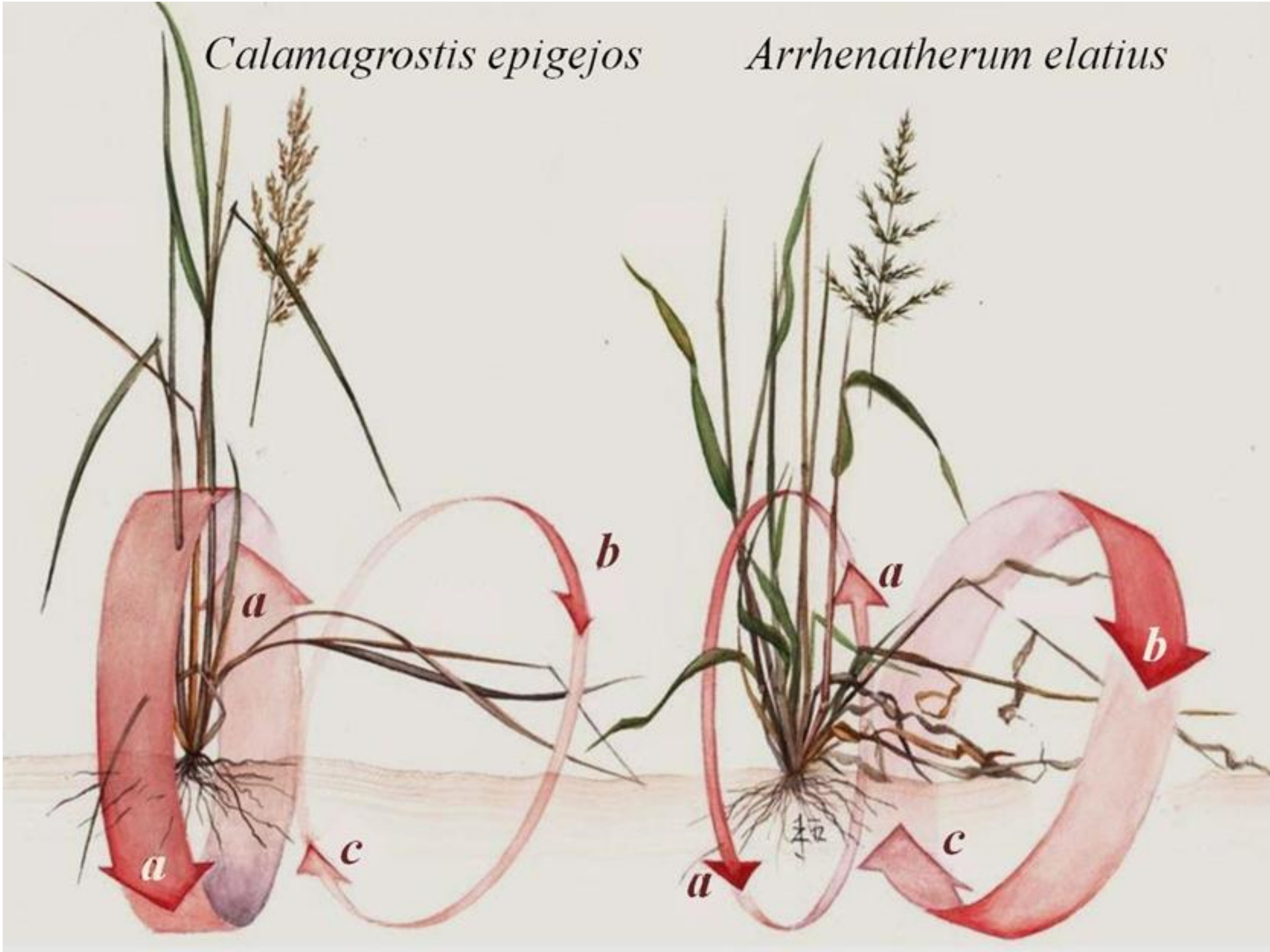


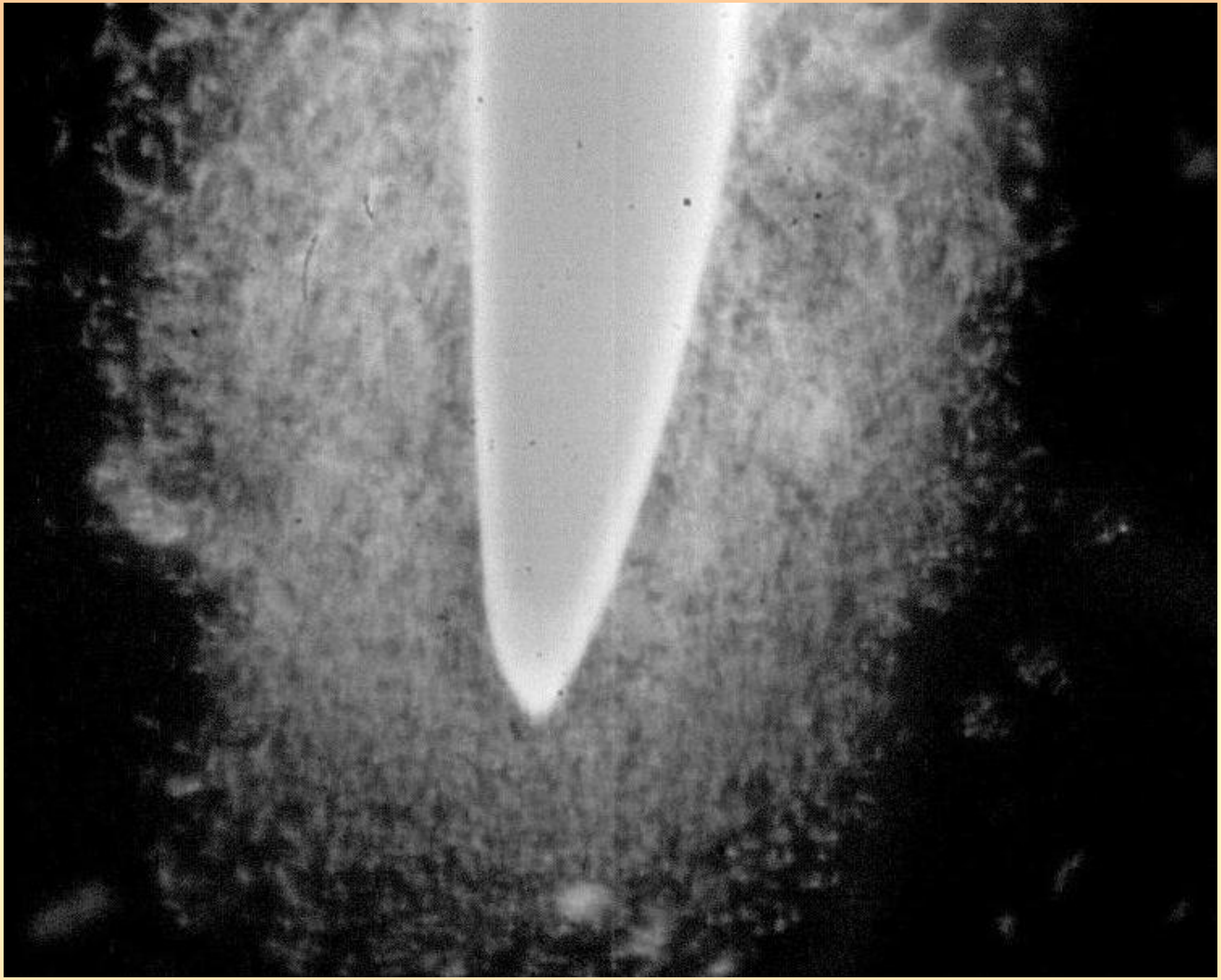
Obr. 4. Souhrnný záchyt amonného a nitrátového dusíku z atmosférického spadu v letech 2005 a 2006 na lokalitách Kraví hora a Havraníky

Vysvětlivky: KH, H – v jednoduchých nádobách v úrovni vegetace, KHS, HS – v nádobách opatřených svazkem nylonové síťoviny

Potentillo arenariae–Agrostietum vinealis

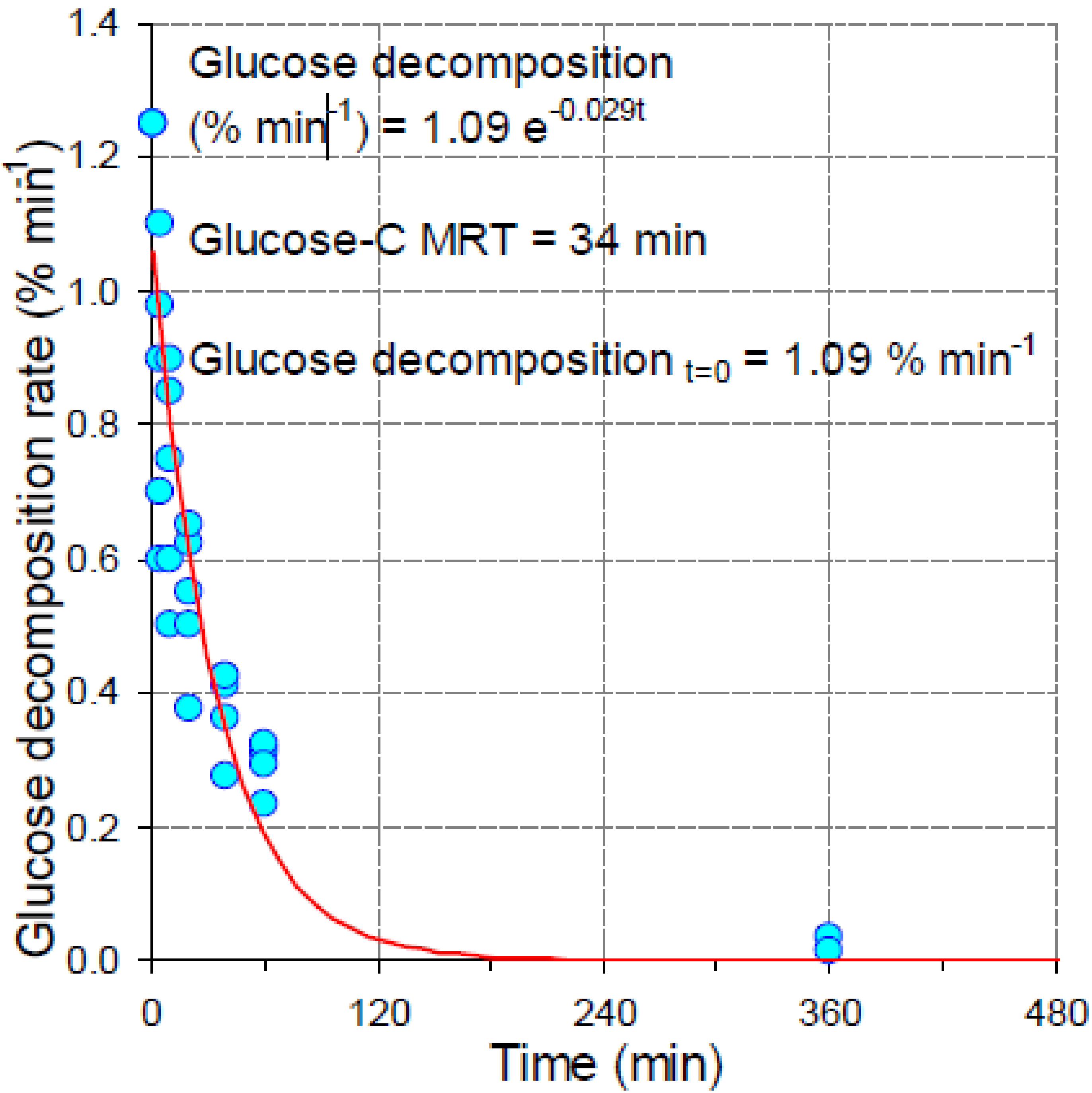
(Carici humilis-Callunetum)


Calamagrostis epigejos
Arrhenatherum elatius
a
a
b
c
a
a
b
c



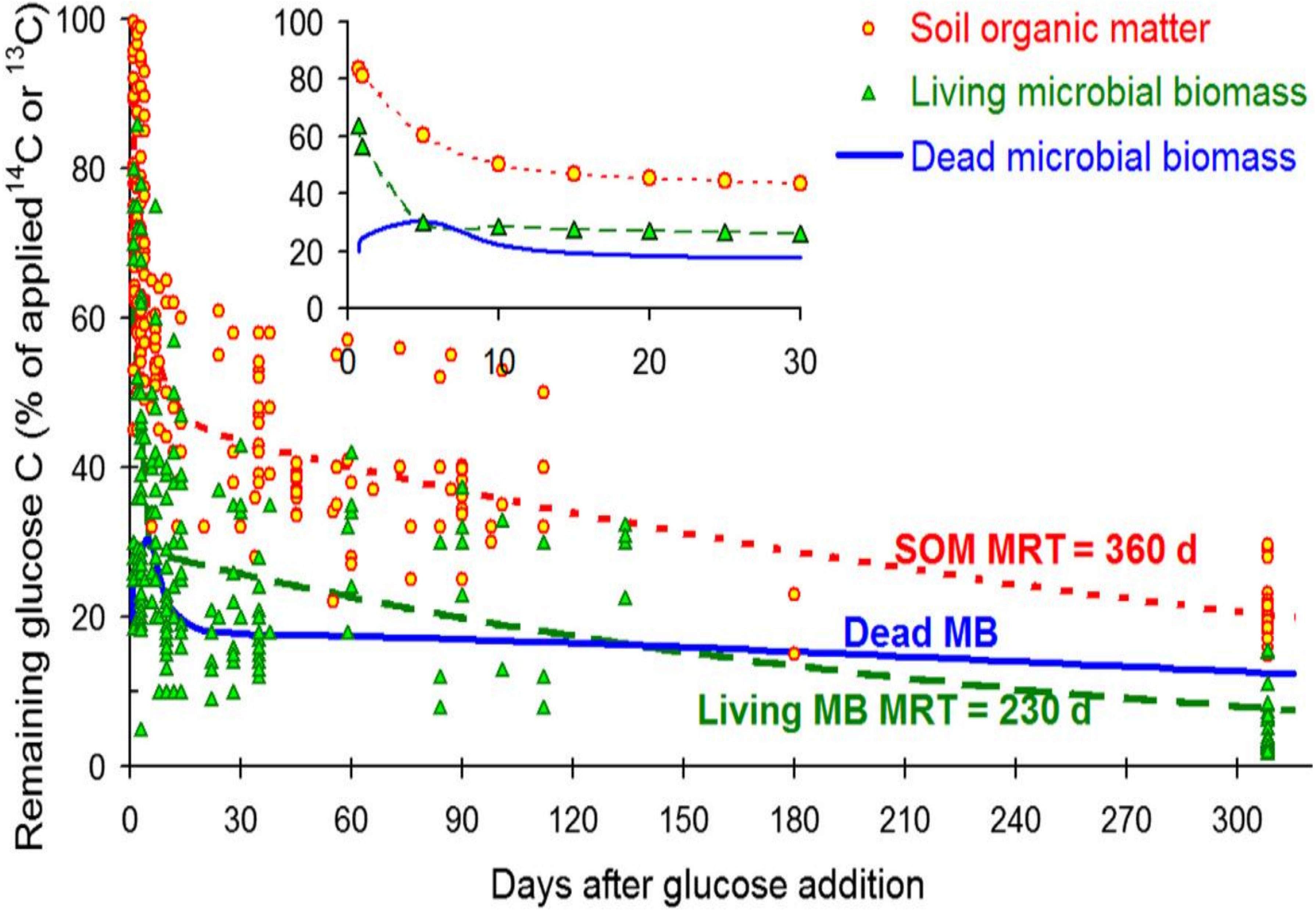
Vylučování mucilagu a uvolňování buněk z kořenové čepičky na vrcholu kořene bavlníku, 30 sekund po ponoření do vody.

Courtesy Gilberto Curlango-Rivera (University of Arizona, Tucson, Arizona), et al.
Read more at: http://phys.org/news/2013-09-secret-life-underground-microbes-root.html#jCp



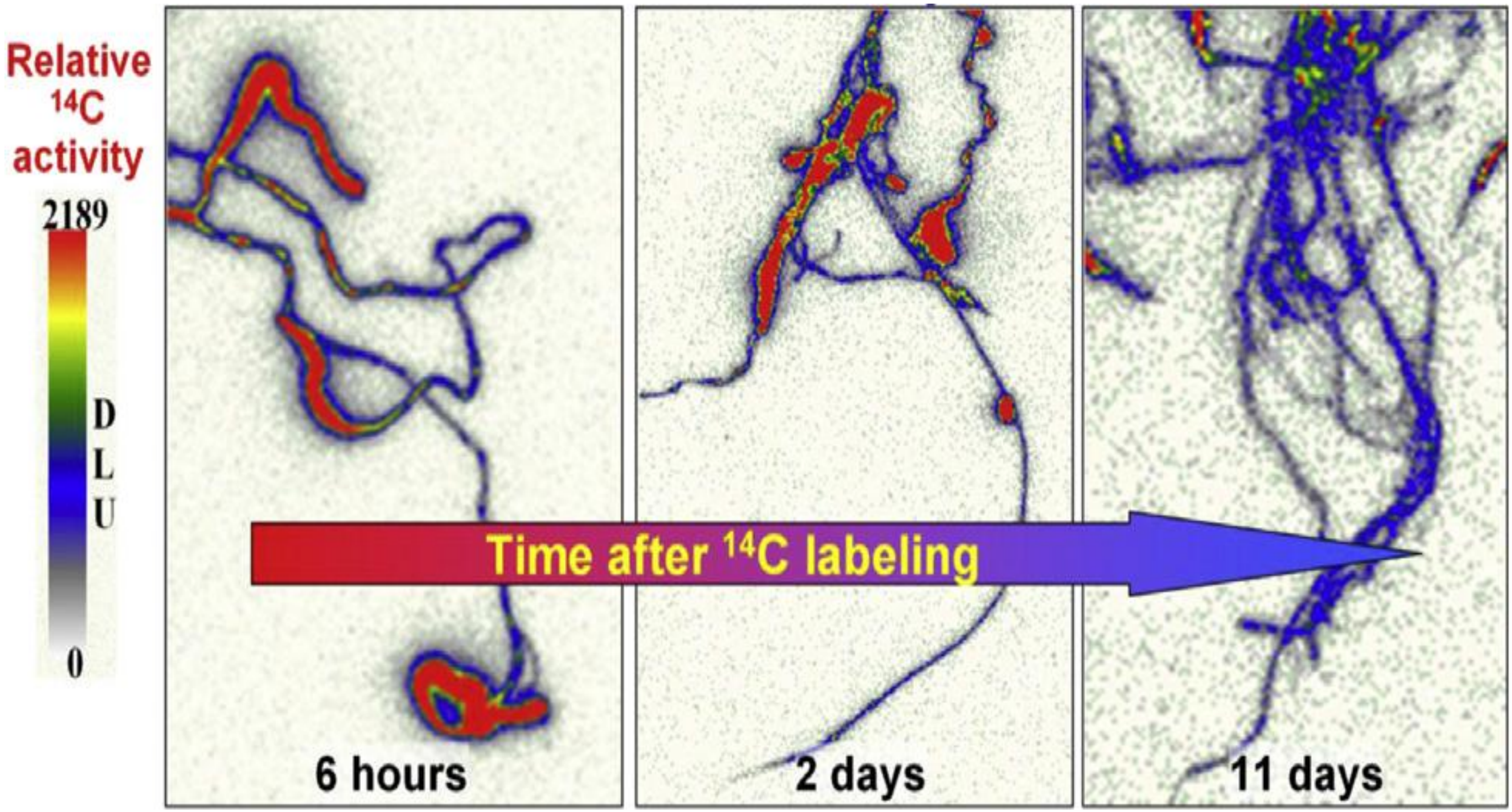
Rates of glucose mineralization in soil estimated based on $^{14}CO_2$ or $^{13}CO_2$ emission. These rates reflect the original glucose before its incorporation into microbial products.

A. Gunina, Y. Kuzyakov / Soil Biology & Biochemistry 90 (2015) 87e100



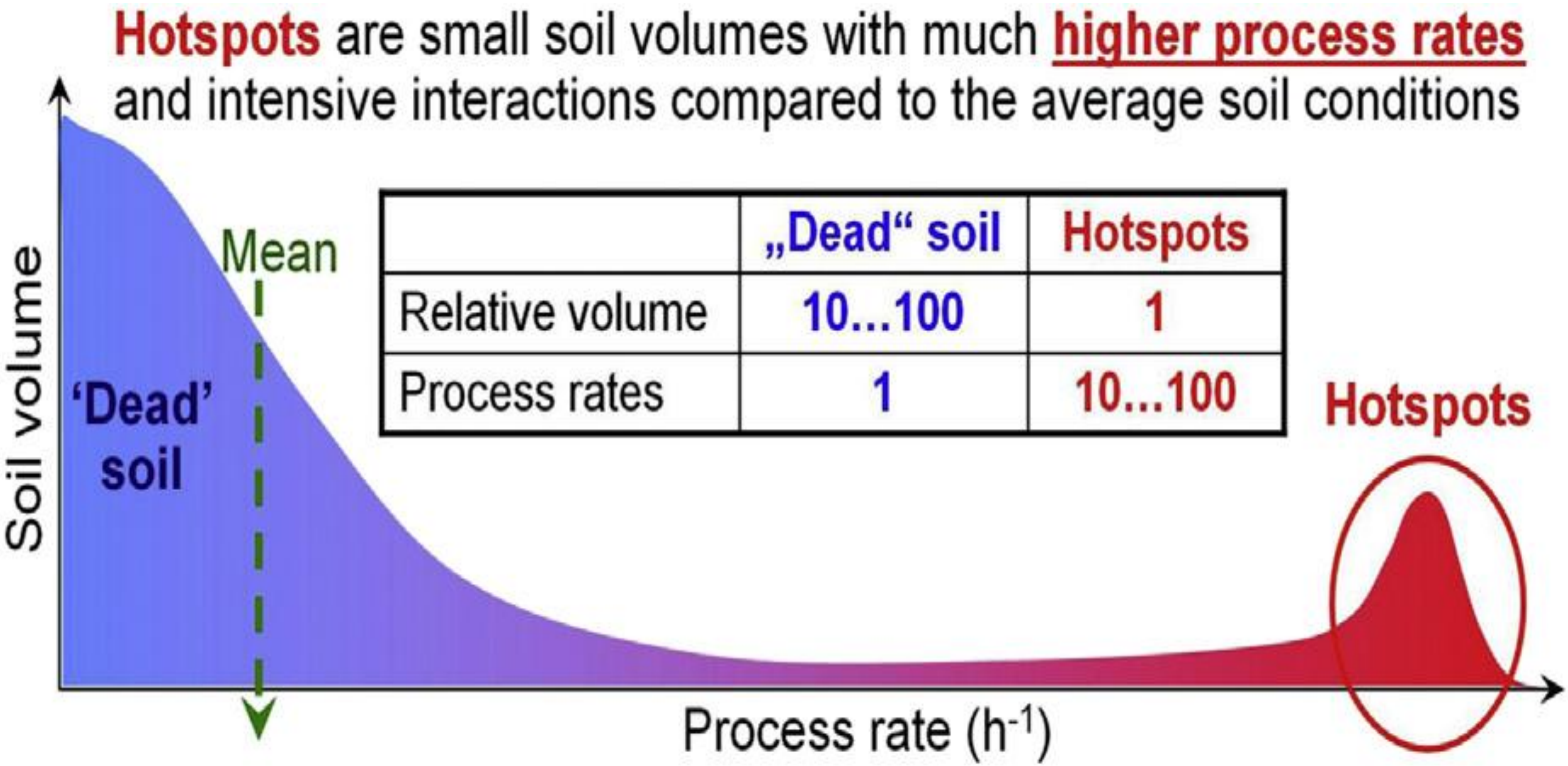
Dynamics and partitioning of glucose-C for three pools: living microbial biomass, microbial residues and SOM. The experimental points (N = 451) are based on the 2nd database of 32 ^{14}C and ^{13}C labeling studies

A. Gunina, Y. Kuzyakov / Soil Biology & Biochemistry 90 (2015) 87e100



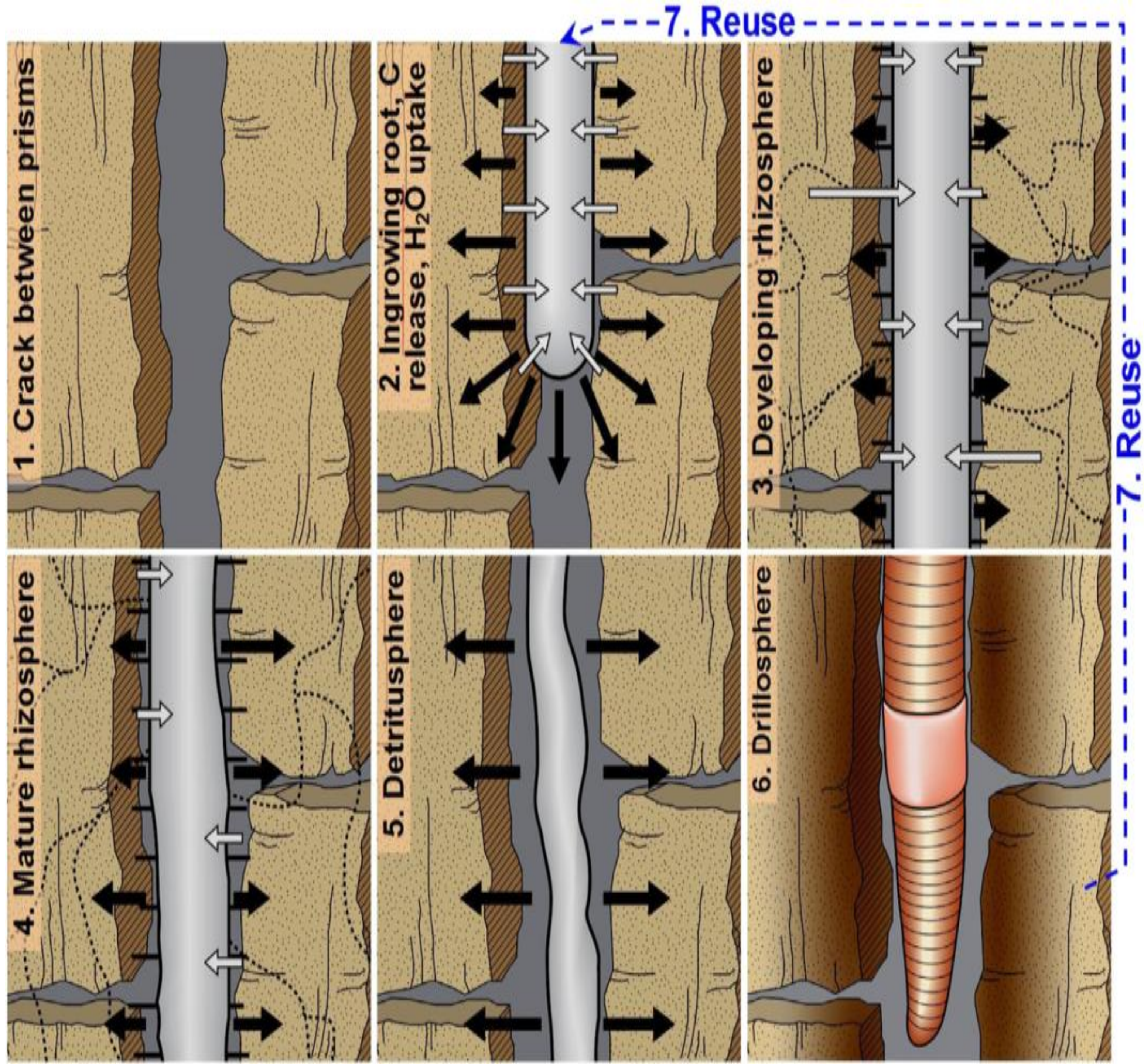
^{14}C imaging of relative ^{14}C activity at the root tips at increasing time after labeling of *Lolium perenne* in $^{14}CO_2$ atmosphere: 6 h, 2 d, and 11 d after the ^{14}C labeling. The color scale presents the ^{14}C activity as digital light units (DLU) (from Pausch and Kuzyakov, 2011, changed)

Y. Kuzyakov, 186 E. Blagodatskaya / Soil Biology & Biochemistry 83 (2015) 184-199



Concept of microbial hotspots in soil: Hotspots are small soil volumes with much higher process rates and intensive interactions compared to the average soil conditions. The Table inset represents the relative volume and process rates in the hotspots and bulk soil. “Mean” represents the weighted average process rates by soil mixing.

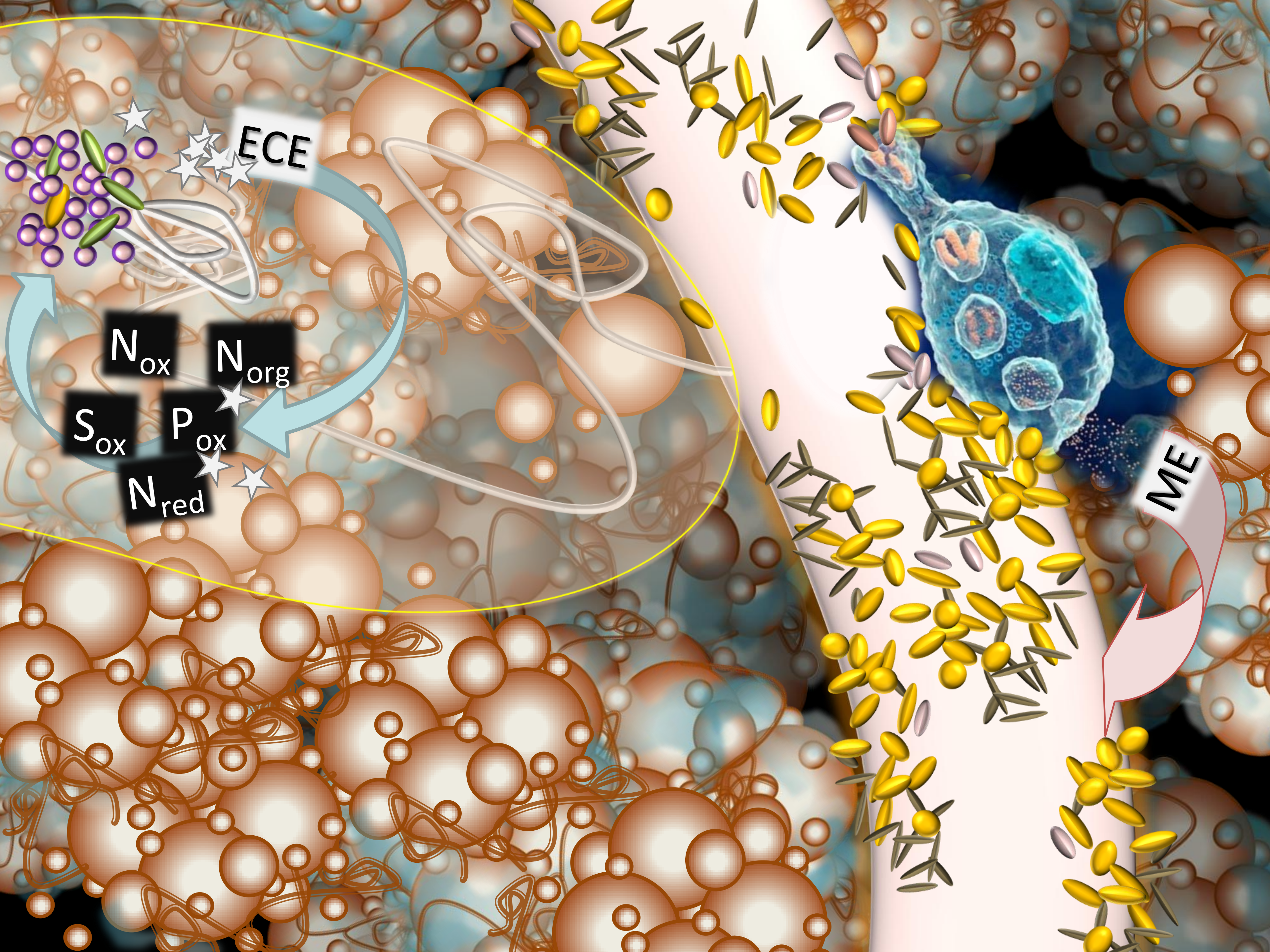
Y. Kuzyakov, 186 E. Blagodatskaya / Soil Biology & Biochemistry 83 (2015) 184-199



Transition between the hotspots of multiple origins:

1) Crack between aggregates,
2) Juvenile rhizosphere: root ingrowing in the crack between aggregates,
3) Developing rhizosphere,
4) Mature rhizosphere,
5) Detritusphere: dying root,
6) Biopore: occupation of rhizosphere-detritusphere environment by earthworms,
7) Reuse of the existing hotspots: - back to ingrowing root and the rhizosphere. Black arrows show the C release by rhizodeposition; weight arrows present the uptake of water and nutrients; black dotted lines reflect mycorrhizal hyphae.

Y. Kuzyakov, 186 E. Blagodatskaya / Soil Biology & Biochemistry 83 (2015) 184-199


ECE
N_{ox}
N_{org}
S_{ox}
P_{ox}
N_{red}
ME


https://word6536.wordpress.com/

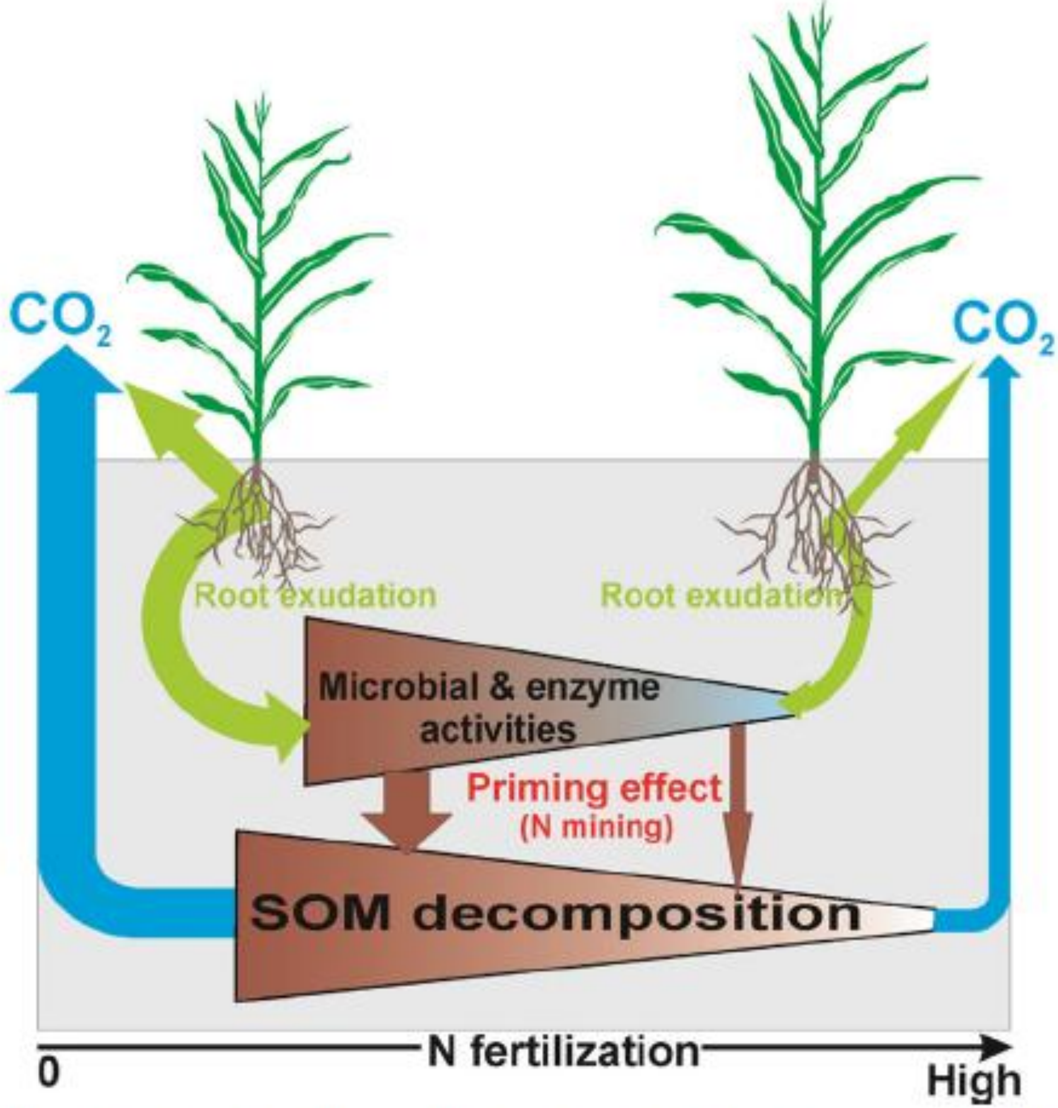



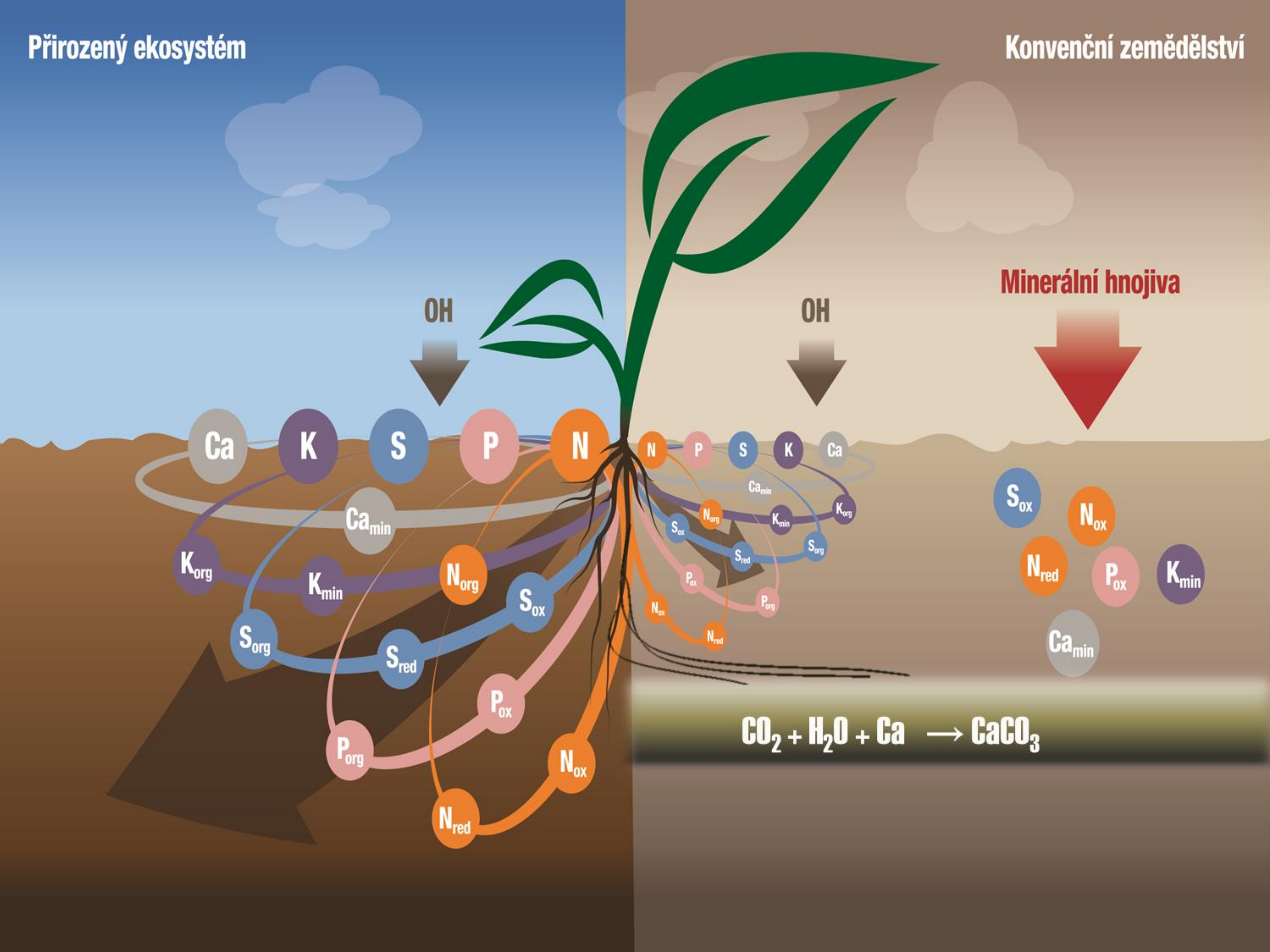
Fig. 7 Conceptual figure showing rhizosphere priming on SOM decomposition accompanied by microbial activation and N mining. Arrow thickness indicates process intensity

Plant Soil (2016) 409:87–97
DOI 10.1007/s11104-016-2958-2

REGULAR ARTICLE

Maize rhizosphere priming: field estimates using ^{13}C natural abundance

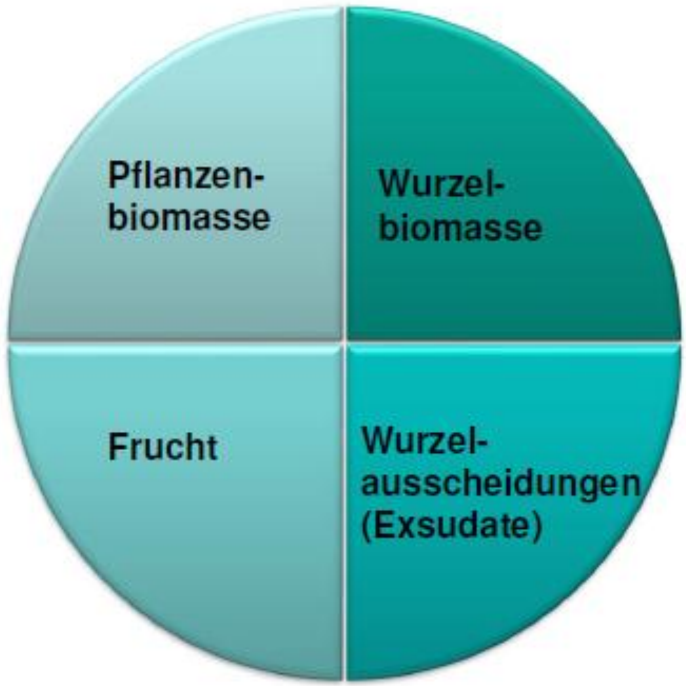
Amit Kumar · Yakov Kuzyakov · Johanna Pausch



Přirozený ekosystém
Konvenční zemědělství
OH
Ca
K
S
P
N
Ca_{min}
K_{org}
K_{min}
N_{org}
S_{ox}
S_{org}
S_{red}
P_{ox}
P_{org}
N_{ox}
N_{red}
OH
N
P
S
K
Ca
Ca_{min}
N_{org}
K_{min}
K_{org}
S_{ox}
S_{red}
S_{org}
P_{ox}
P_{org}
N_{ox}
N_{red}
Minerální hnojiva
S_{ox}
N_{ox}
N_{red}
P_{ox}
K_{min}
Ca_{min}
$CO_2 + H_2O + Ca \longrightarrow CaCO_3$

Maiswurzelausbildung in Abhängigkeit von der Zwischenfrucht vor Mais

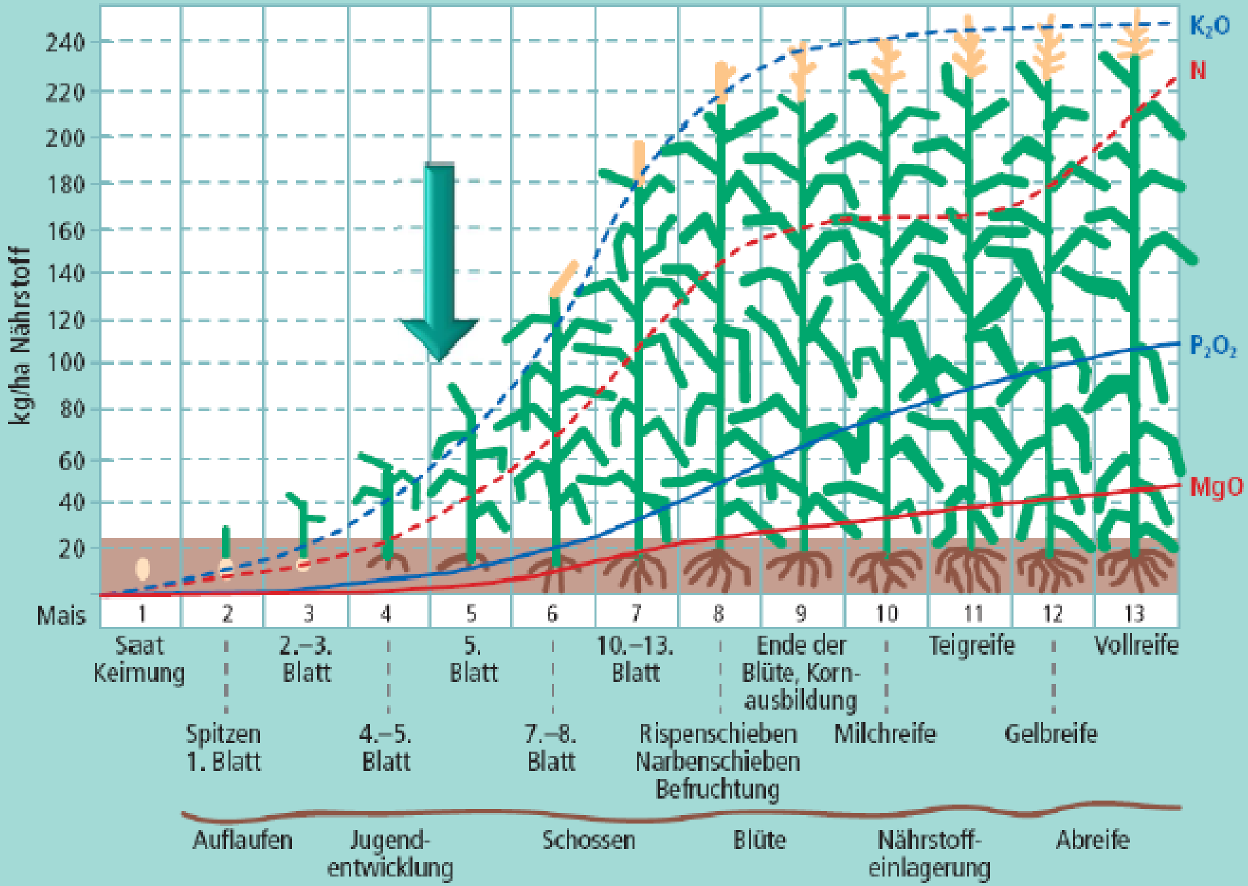
ca. 50 % der Pflanzenbiomasse befindet sich im Boden



Quelle: J. Kempf, 2015, verändert

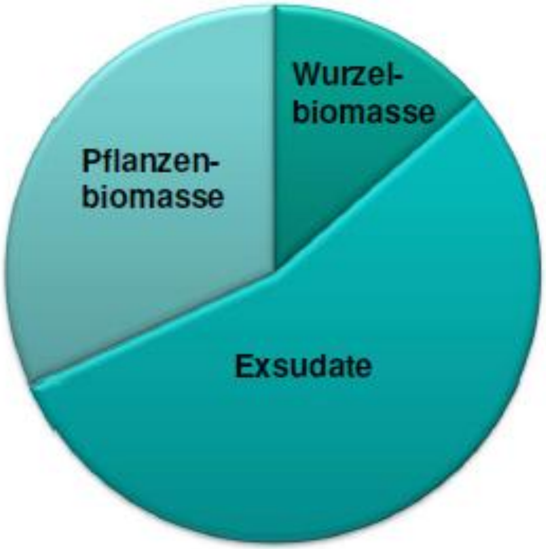
3- 5 Blattstadium

Verlauf der Nährstoffaufnahme und Entwicklungsstadien von Körnermais

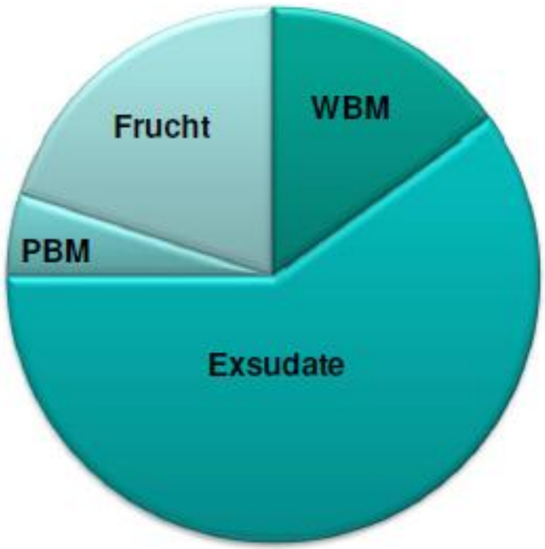


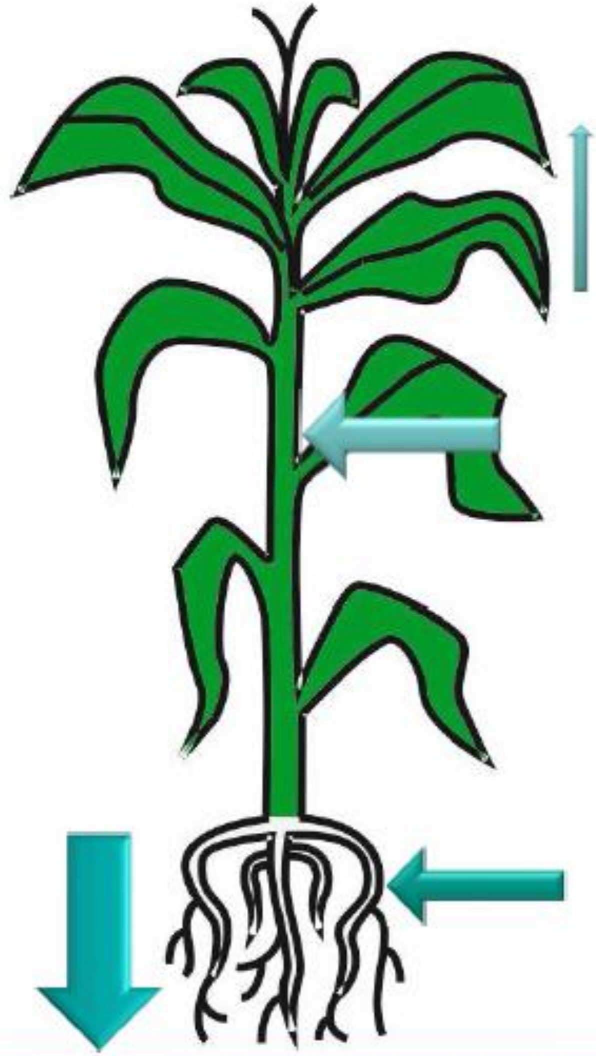
Quelle: Buchner, Sturm, 1980

6- 13 Blattstadium

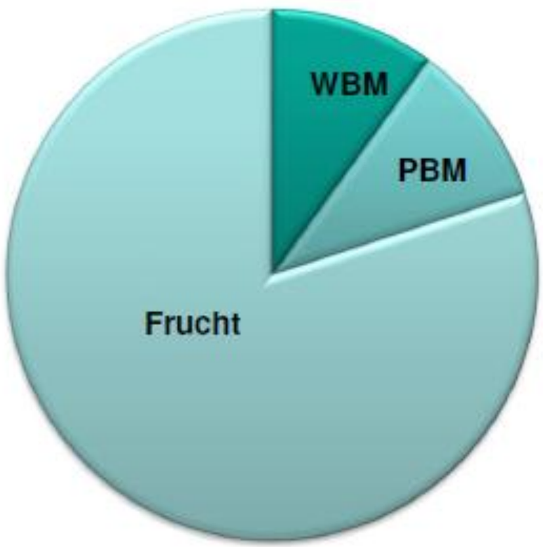


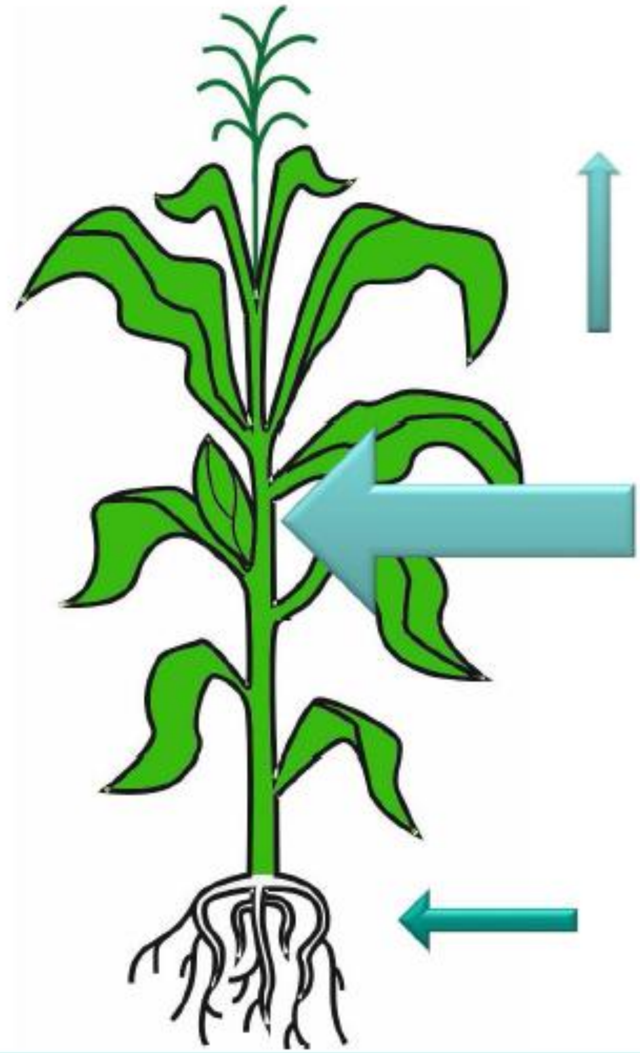
Beginn Fruchtbildung





Fruchtbildung





Quelle: J. Kempf, 2015, verändert

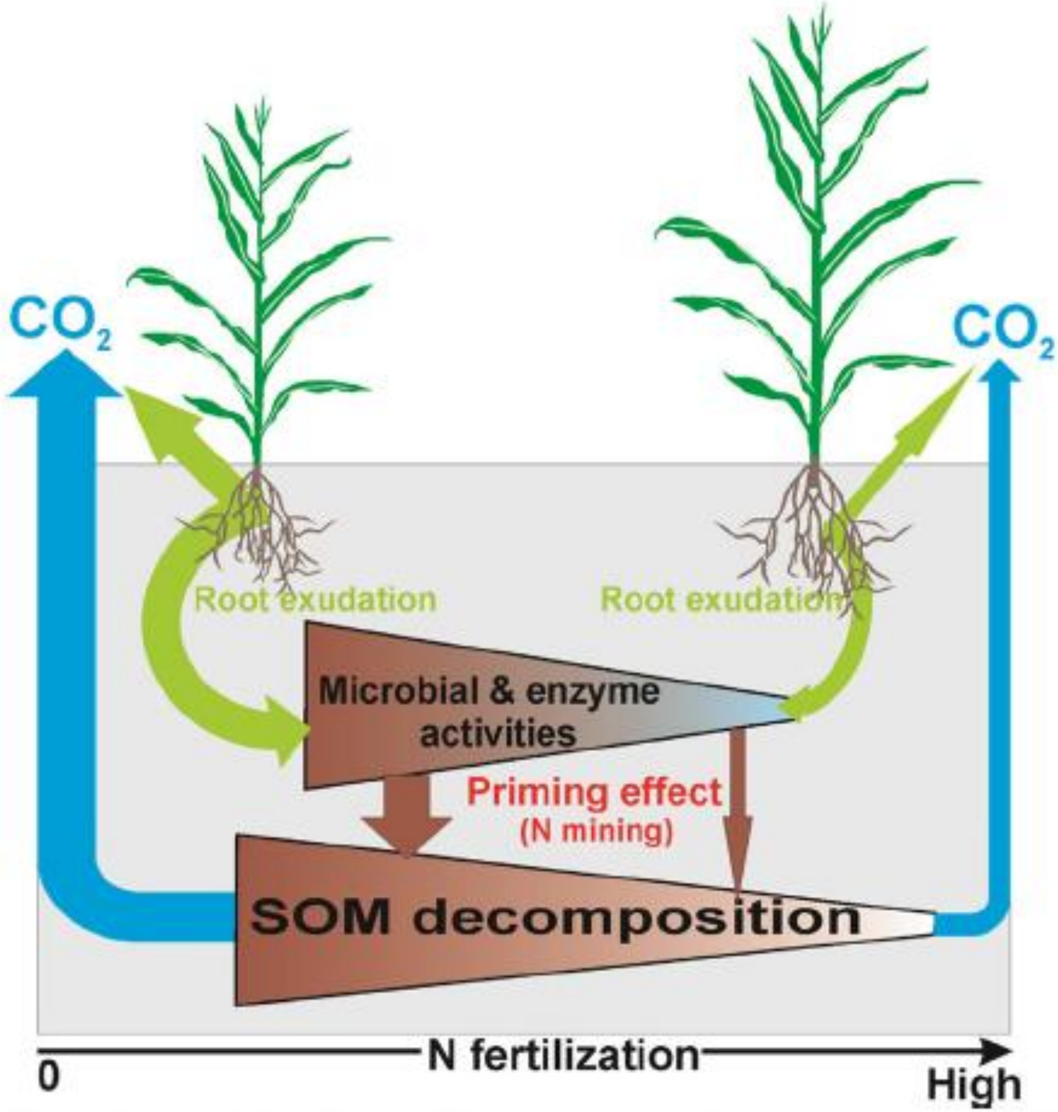


Fig. 7 Conceptual figure showing rhizosphere priming on SOM decomposition accompanied by microbial activation and N mining. Arrow thickness indicates process intensity

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REGULAR ARTICLE

Maize rhizosphere priming: field estimates using ^{13}C natural abundance

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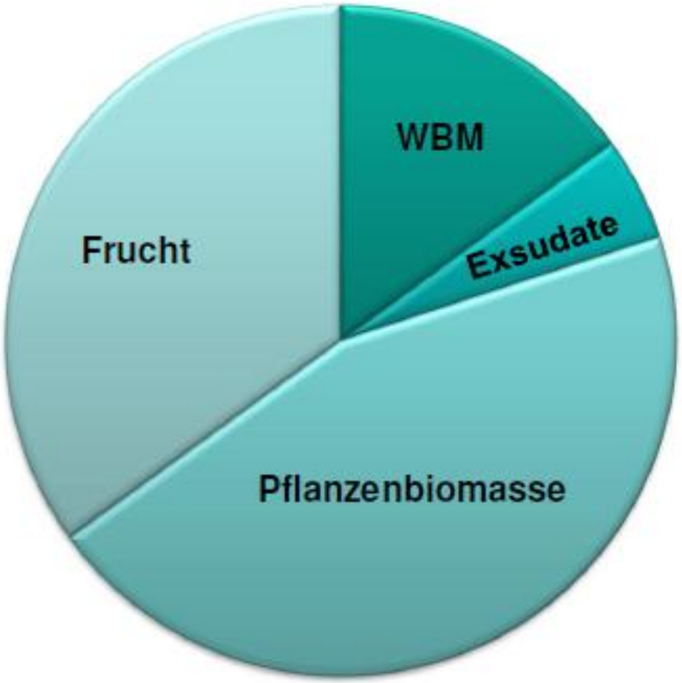
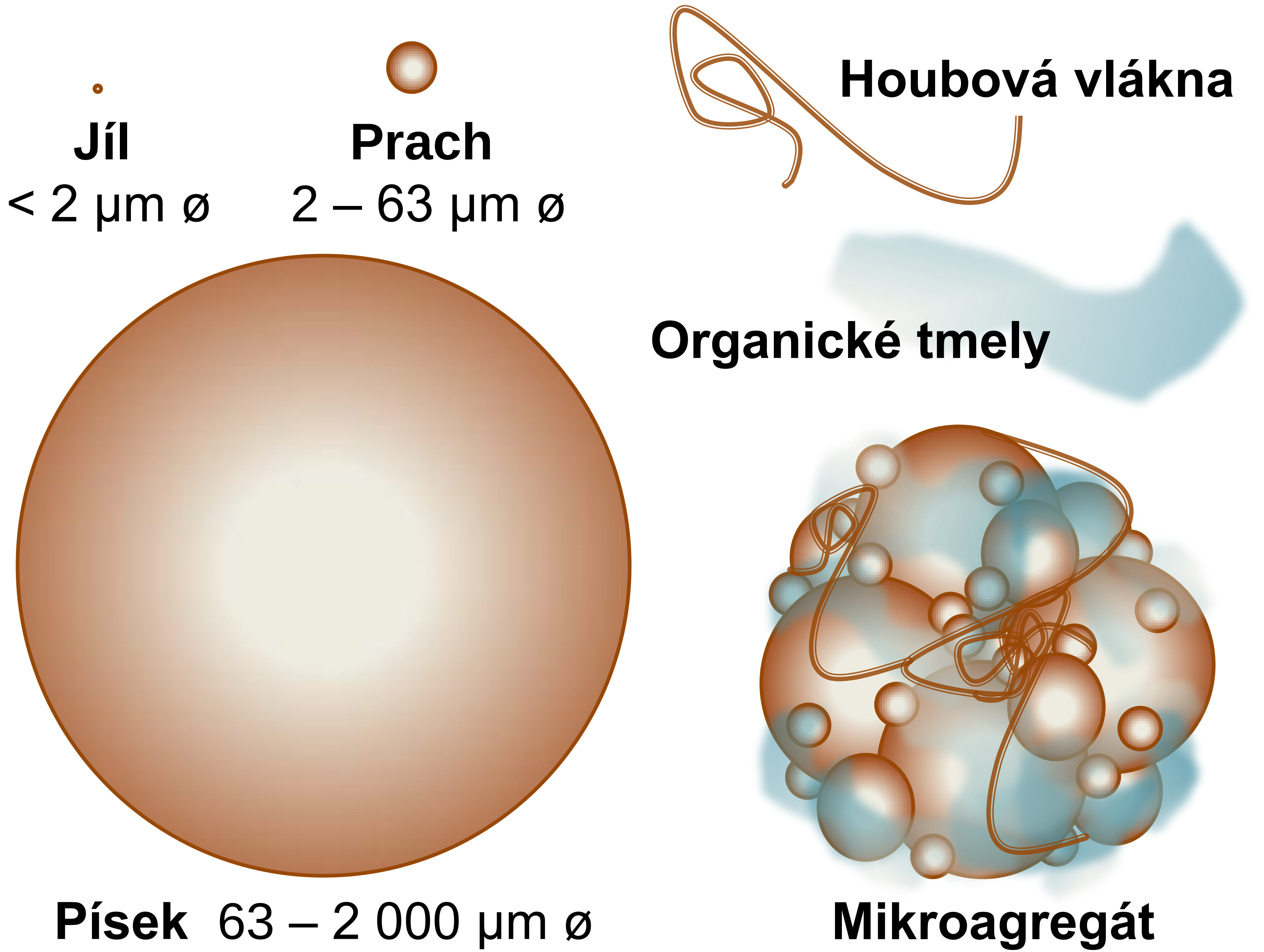
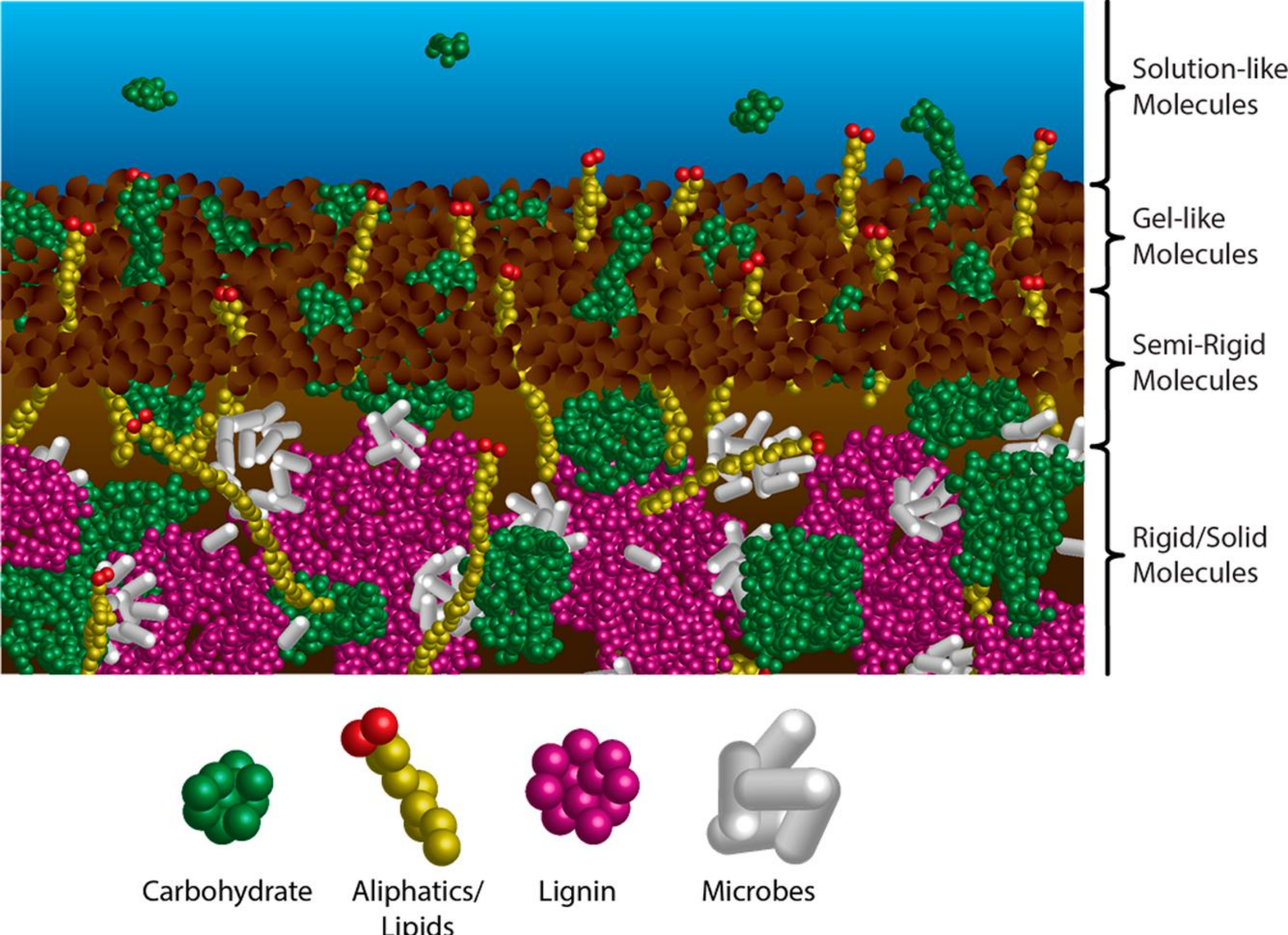
Ergebnis im gestörtem Boden:

„Mit *gewöhnlicher* Photosynthese“




Jíl
< 2 µm ø
Prach
2 – 63 µm ø
Houbová vlákna
Organické tmely
Písek 63 – 2 000 µm ø
Mikroagregát



Masoom Hussain et al., Environ. Sci. Technol. 2016, 50, 1670–1680

PLFA Soil Microbial Community Analysis

Functional Group Biomass & Diversity

Total Living Microbial Biomass, Phospholipid Fatty Acid (PLFA) ng/g	**2113.78**
Functional Group Diversity Index	**1.611**

Total Biomass	Diversity	Rating
< 500	< 1.0	Very Poor
500+ - 1000	1.0+ - 1.1	Poor
1000+ - 1500	1.1+ - 1.2	Slightly Below Average
1500+ - 2500	1.2+ - 1.3	Average
2500+ - 3000	1.3+ - 1.4	Slightly Above Average
3000+ - 3500	1.4+ - 1.5	Good
3500+ - 4000	1.5+ - 1.6	Very Good
> 4000	> 1.6	Excellent

Functional Group	Biomass, PLFA ng/g	% of Total Biomass
Total Bacteria	**999.83**	**47.30**
Gram (+)	**502.21**	**23.76**
Actinomycetes	150.08	7.10
Gram (-)	**497.62**	**23.54**
Rhizobia	44.93	2.13
Total Fungi	**276.16**	**13.06**
Arbuscular Mycorrhizal	**80.56**	**3.81**
Saprophytes	**195.59**	**9.25**
Protozoa	**20.46**	**0.97**
Undifferentiated	**817.34**	**38.67**

PLFA Soil Microbial Community Analysis

Functional Group Biomass & Diversity

Total Living Microbial Biomass, Phospholipid Fatty Acid (PLFA) ng/g **540.41**
Functional Group Diversity Index **1.046**

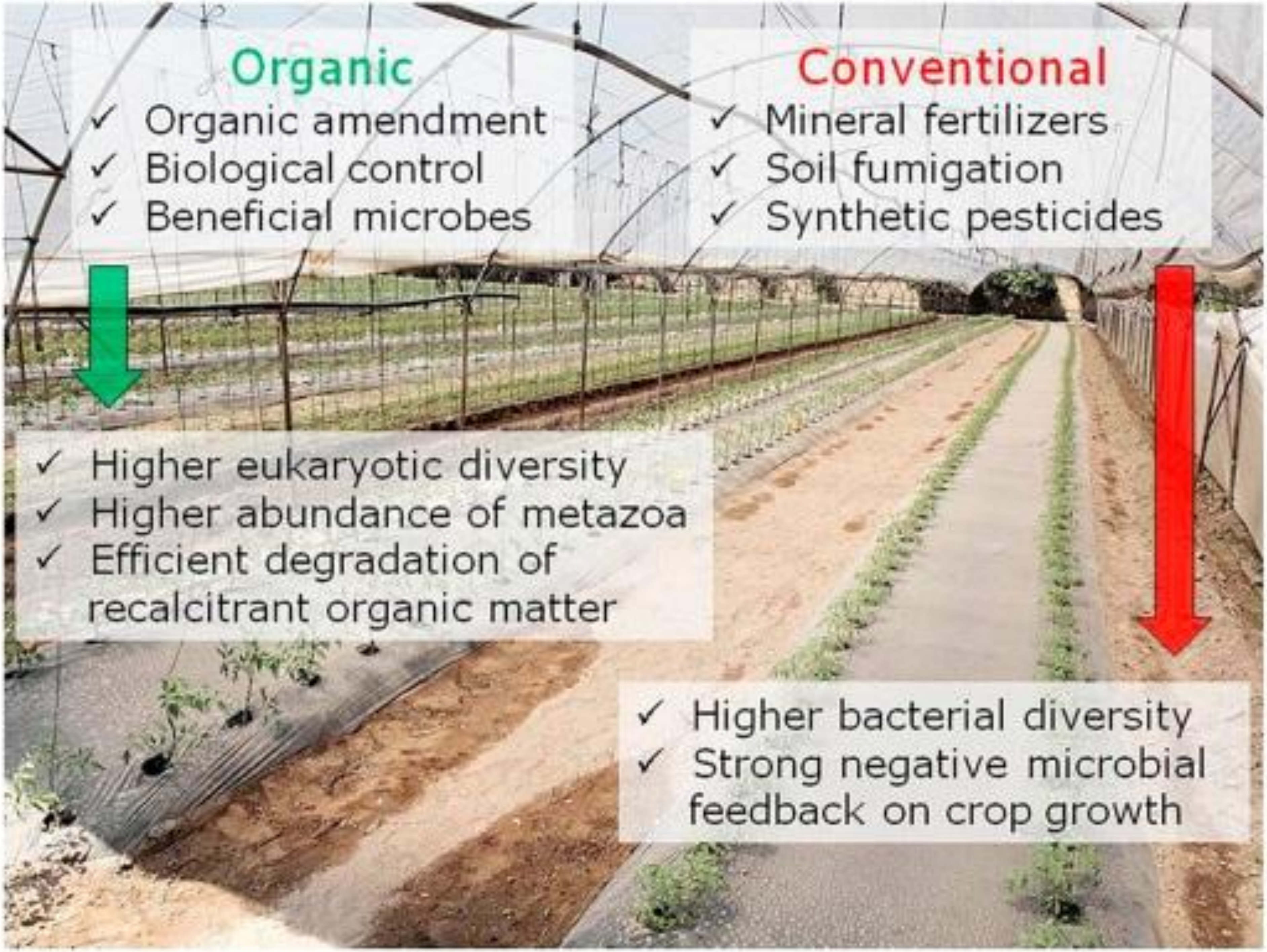
Total Biomass	Diversity	Rating
< 500	< 1.0	Very Poor
500+ - 1000	1.0+ - 1.1	Poor
1000+ - 1500	1.1+ - 1.2	Slightly Below Average
1500+ - 2500	1.2+ - 1.3	Average
2500+ - 3000	1.3+ - 1.4	Slightly Above Average
3000+ - 3500	1.4+ - 1.5	Good
3500+ - 4000	1.5+ - 1.6	Very Good
> 4000	> 1.6	Excellent

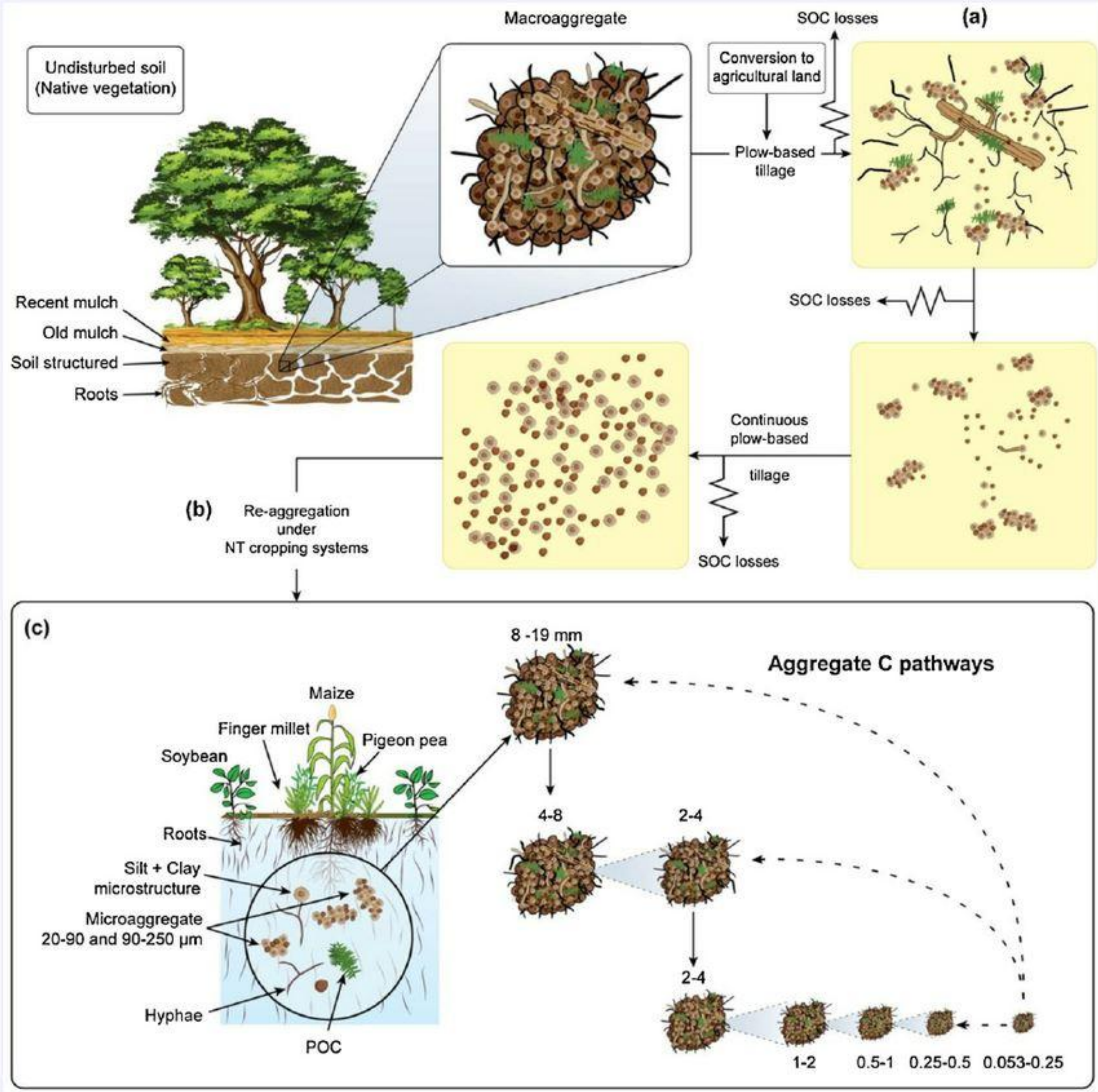
Functional Group	Biomass, PLFA ng/g	% of Total Biomass
Total Bacteria	**341.53**	**63.20**
Gram (+)	**298.53**	**55.24**
Actinomycetes	90.31	16.71
Gram (-)	**43.00**	**7.96**
Rhizobia	0.00	0.00
Total Fungi	**14.35**	**2.66**
Arbuscular Mycorrhizal	**0.00**	**0.00**
Saprophytes	**14.35**	**2.66**
Protozoa	**0.00**	**0.00**
Undifferentiated	**184.53**	**34.15**


bioforschung
Maschinenring
Projekt MinNC
Senning: Parzelle 5
Leguminosen + Nichtleg.
abfrostend „BFA1“
Begrünungsanbau: 04.08.2017
VF: Wickroggen
Grobkörniges und feinkörniges Saatgut wurden getrennt mit dem SuperMaxx in einem Arbeitsgang ausgebracht. Die Parzelle wurde am 21.07.2017 vorgegrubbert.
Saatstärke des groben & feinen Saatgutes:
135kg/ha
Platterbse
Sandhafer
Sommerwicke (Mery)
Ackerbohne (Fuego)
15kg/ha
Phacelia (Mewa)
Alexandrinerklee (Alex)
Perserklee (Gorby)
Ölrettich (Radetzky)
Leindotter
Kresse
LE 14-20

Unterirdische Leistung der Begrünungspflanzen,
Begrünungsversuch Stockerau 2010


Děkuji za pozornost


Organic
✓ Organic amendment
✓ Biological control
✓ Beneficial microbes
Conventional
✓ Mineral fertilizers
✓ Soil fumigation
✓ Synthetic pesticides
✓ Higher eukaryotic diversity
✓ Higher abundance of metazoa
✓ Efficient degradation of recalcitrant organic matter
✓ Higher bacterial diversity
✓ Strong negative microbial feedback on crop growth



Soil& Tillage Research126 (2013) 203–218

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Soil & Tillage Research

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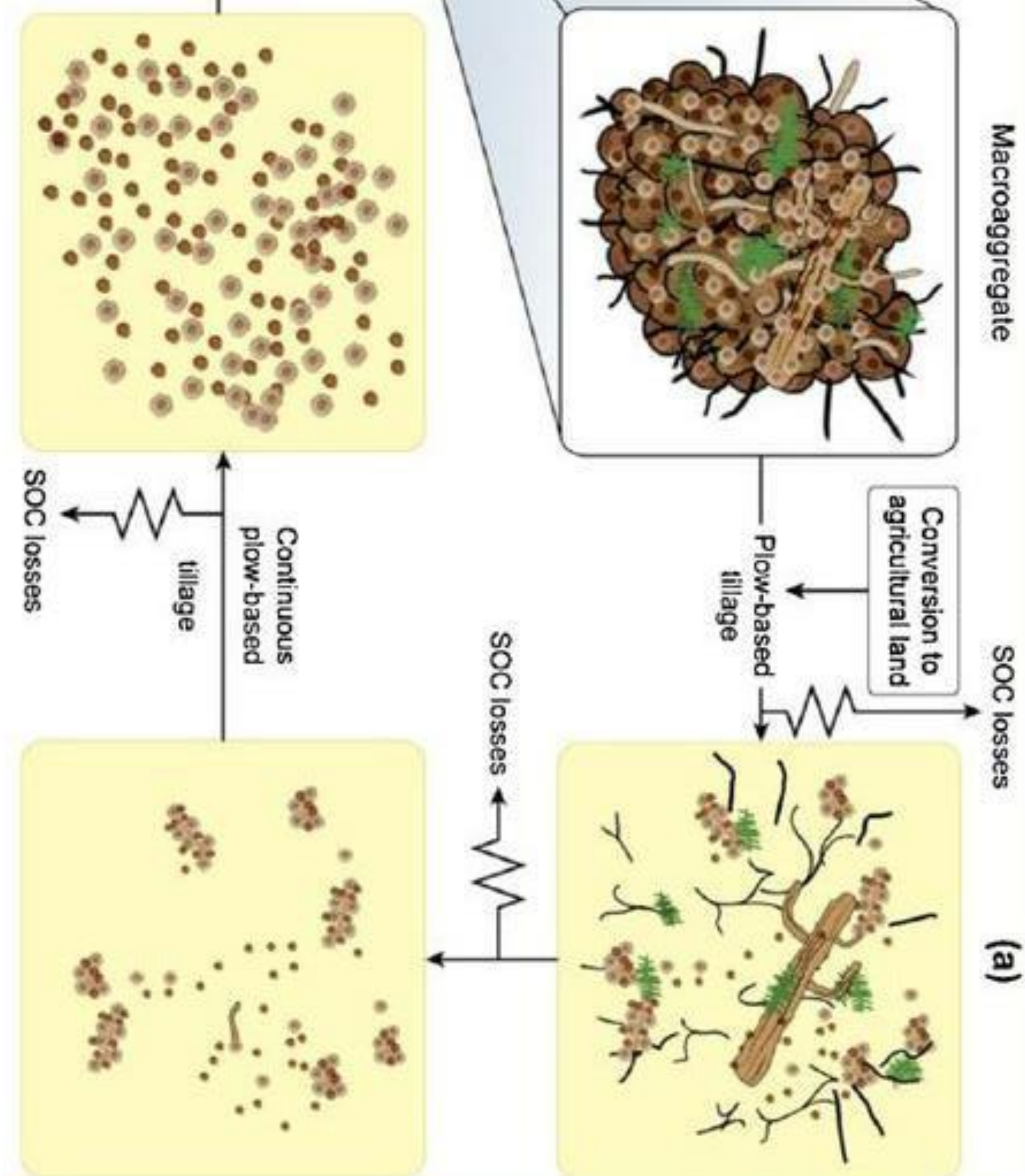

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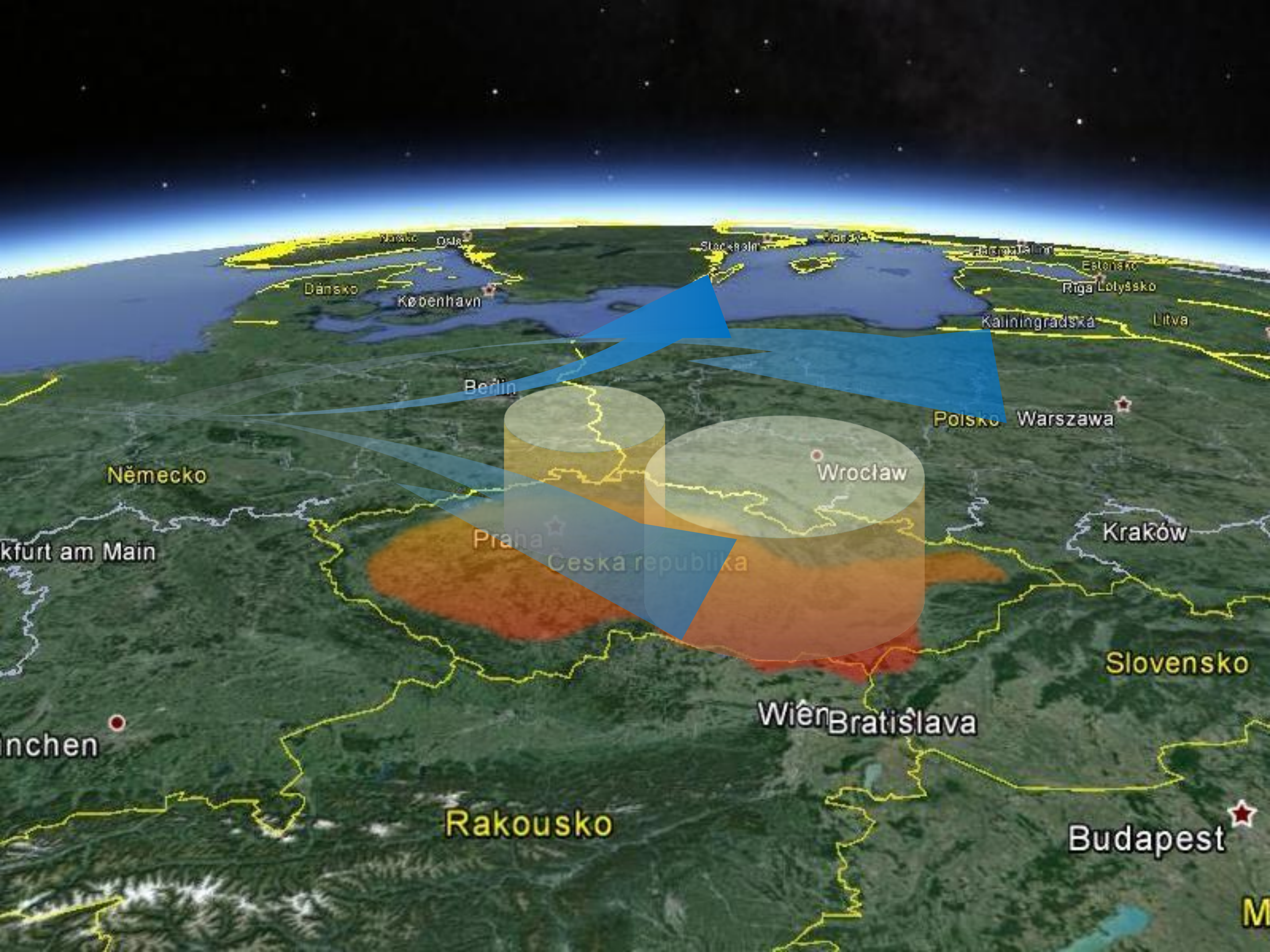
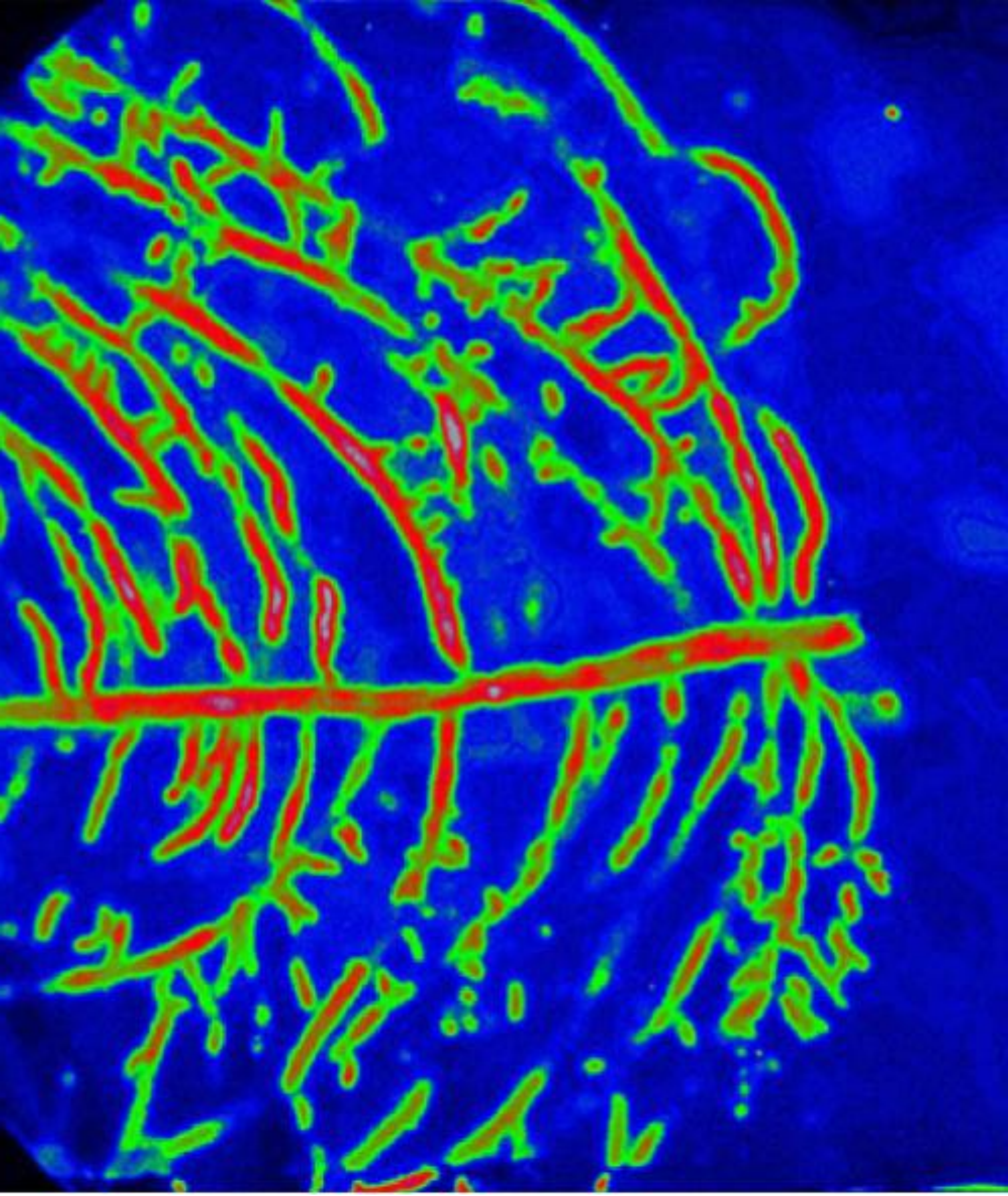

Dánsko
København
Estonsko
Riga
Lotyšsko
Kaliningradská
Litva
Berlin
Polsko
Warszawa
Wrocław
Německo
Praha
Česká republika
kfurt am Main
Kraków
Slovensko
nchen
Wien
Bratislava
Rakousko
Budapest

Considerations for No-Till

Tyler Williams
University of Nebraska
Extension Educator
Applied Ag Climatologist



Activity of acid phosphatase by zymography of lupine roots.

Kuzyakov et al. , University of Göttingen, Germany

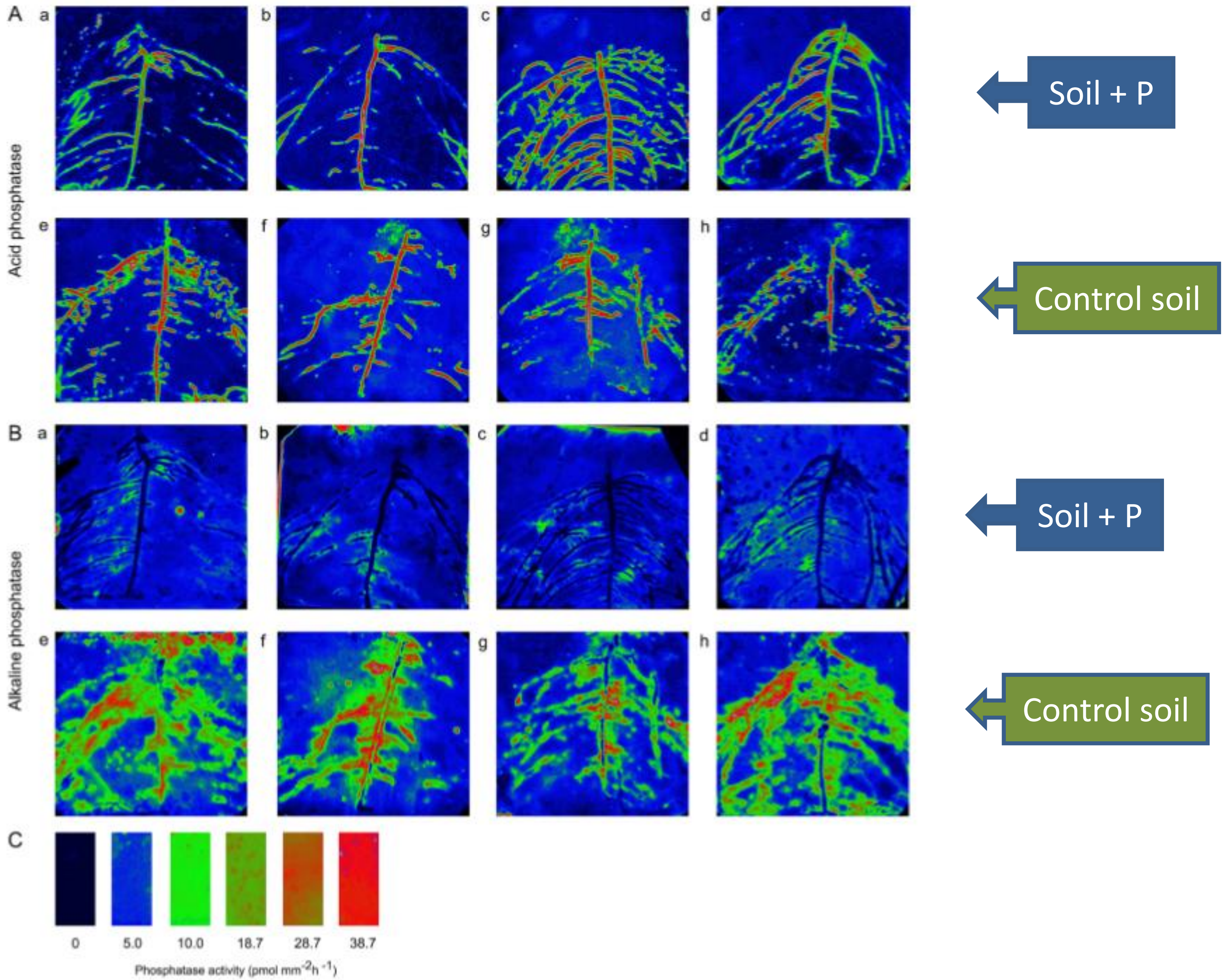


Fig. 2. Zymograms showing acid phosphatase (A) and alkaline phosphatase (B) together with the calibration line (C) that is composed of six calibration membranes. Images a–d show P amended soils and images e–h show control soils.

Cover crops and their benefits

- Erosion Control
- Nutrient Capture/Cycling
- Improve Soil Health
- Water Management
- Increase Biodiversity
- Balance C:N Ratio
- Nitrogen Fixation
- Reduce Compaction
- Weed Supression
- Provide Forage/Grazing

doi:10.1038/nature16069

The contentious nature of soil organic matter

Johannes Lehmann[1,2*] & Markus Kleber[3,4*]

The exchange of nutrients, energy and carbon between soil organic matter, the soil environment, aquatic systems and the atmosphere is important for agricultural productivity, water quality and climate. Long-standing theory suggests that soil organic matter is composed of inherently stable and chemically unique compounds. Here we argue that the available evidence does not support the formation of large-molecular-size and persistent 'humic substances' in soils. Instead, soil organic matter is a continuum of progressively decomposing organic compounds. We discuss implications of this view of the nature of soil organic matter for aquatic health, soil carbon–climate interactions and land management.

Soil organic matter contains more organic carbon than global vegetation and the atmosphere combined (Fig. 1). For this reason, the release and conversion into carbon dioxide or methane of even a small proportion of carbon contained in soil organic matter can cause quantitatively relevant variations in the atmospheric concentrations of these greenhouse gases[1]. Moreover, organic matter retains nutrients as well as pollutants in the soil, which improves plant growth and protects water quality[2]. Soils are also an important source of aquatic carbon, with implications for biogeochemical processes in rivers, lakes and estuaries[3]. Despite its recognized importance, there is a widely divergent view of the nature of soil organic matter.

Biological, physical and chemical transformation processes convert dead plant material into organic products that are able to form intimate associations with soil minerals, making it difficult to study the nature of soil organic matter. Early research based on an extraction method assumed that a 'humification' process creates recalcitrant (resistant to decomposition) and large 'humic substances' to make up the majority of soil 'humus' (see Box 1). However, these 'humic substances' have not been observed by modern analytic techniques. This lack of evidence means that 'humification' is increasingly questioned, yet the underlying theory persists in the contemporary literature, including current textbooks[4–6].

Here we argue in favour of a soil continuum model (SCM) that focuses on the ability of decomposer organisms to access soil organic matter and on the protection of organic matter from decomposition provided by soil minerals. Viewing soil organic matter as a continuum spanning the full range from intact plant material to highly oxidized carbon in carboxylic acids[7] represents robust science and will facilitate the way we communicate between disciplines and with the public. Only such an evidence-based approach can allow for the development of mechanistic solutions to climate, water quality and soil productivity issues (Fig. 1). The resulting knowledge should be integrated into conceptual and mechanistic models for the purpose of predicting carbon dioxide emissions from soils in a warming world, as well as of keeping water supplies clean, and of improving and sustaining the ecosystem services of the world's soils. Research aimed at reliable predictions of soil organic matter turnover should focus on investigating its spatial arrangement within the mineral matrix, the fine-scale redox environment, microbial ecology and interaction with mineral surfaces under moisture and temperature conditions observed in soils.

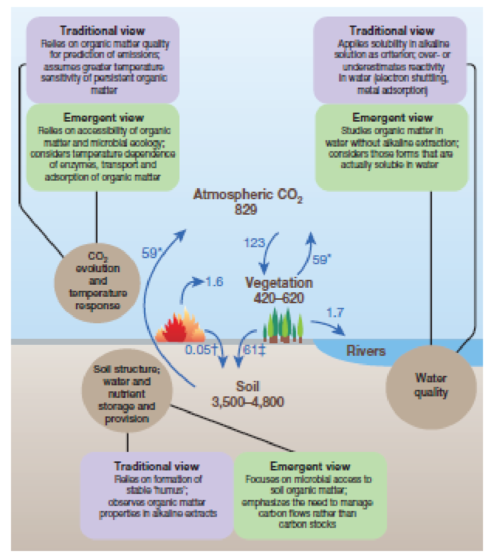


Figure 1 | Traditional and emergent views of the nature of soil organic matter affect how we predict and manage soil, air and water. Traditional 'humification' concepts limit observations of soil organic matter to its solubility in alkaline extracts, unlike the emergent view of organic matter based on solubility in water and its accessibility to microorganisms. Soils are an important source of organic matter in aquatic ecosystems and are responsible for half of the atmospheric carbon recycling. Carbon stocks and flux values are from ref. 1, except where noted otherwise: brown numbers are stocks in Pg C and blue numbers are flows in Pg C yr^{-1}. *Disaggregated value from 119 Pg C yr^{-1} total emissions. †3% of total carbon consumed by fire[104]. ‡Estimate to balance soil carbon exports.

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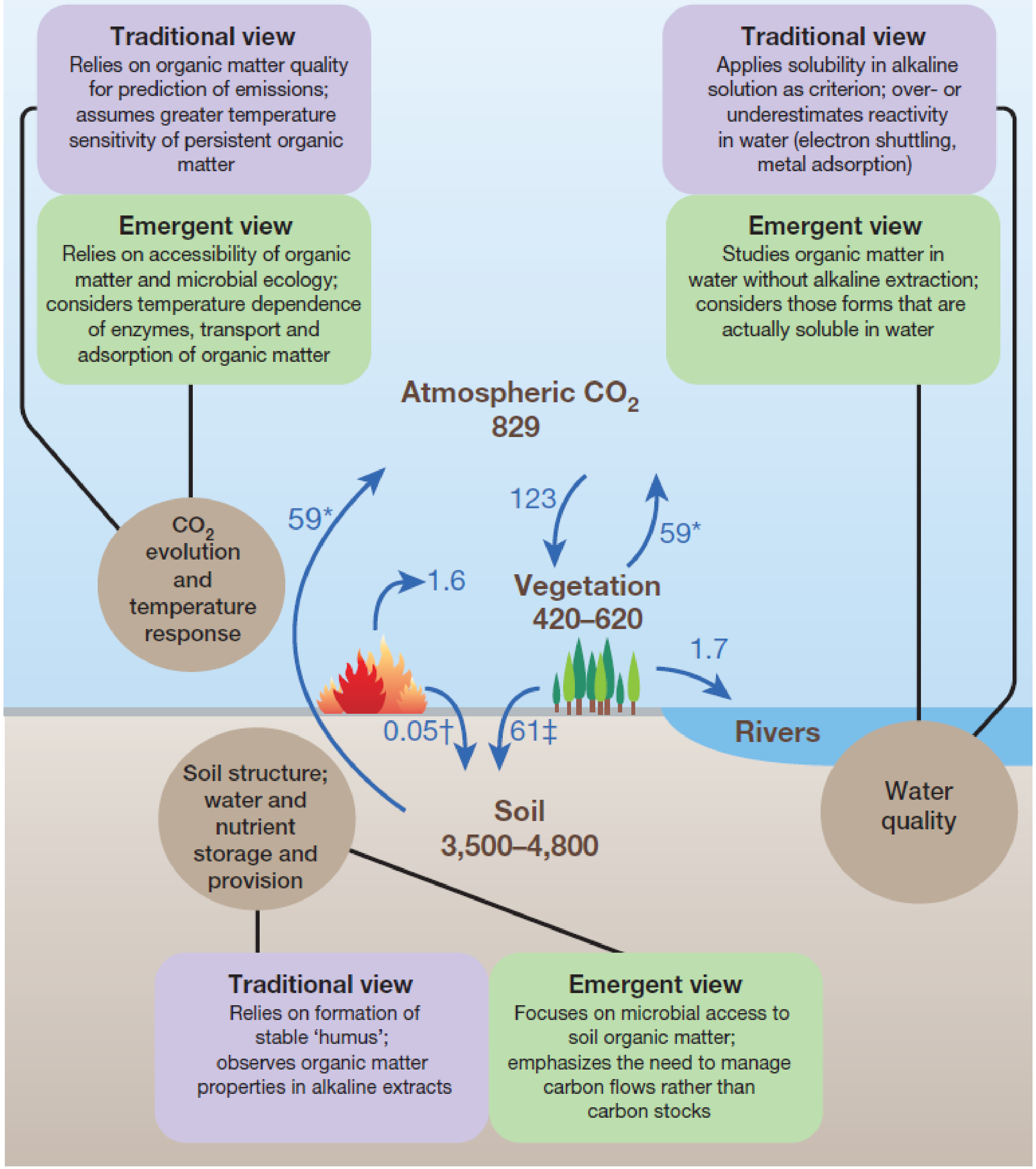
*These authors contributed equally to this work.



Traditional and emergent views of the nature of soil organic matter affect how we predict and manage soil, air and water.

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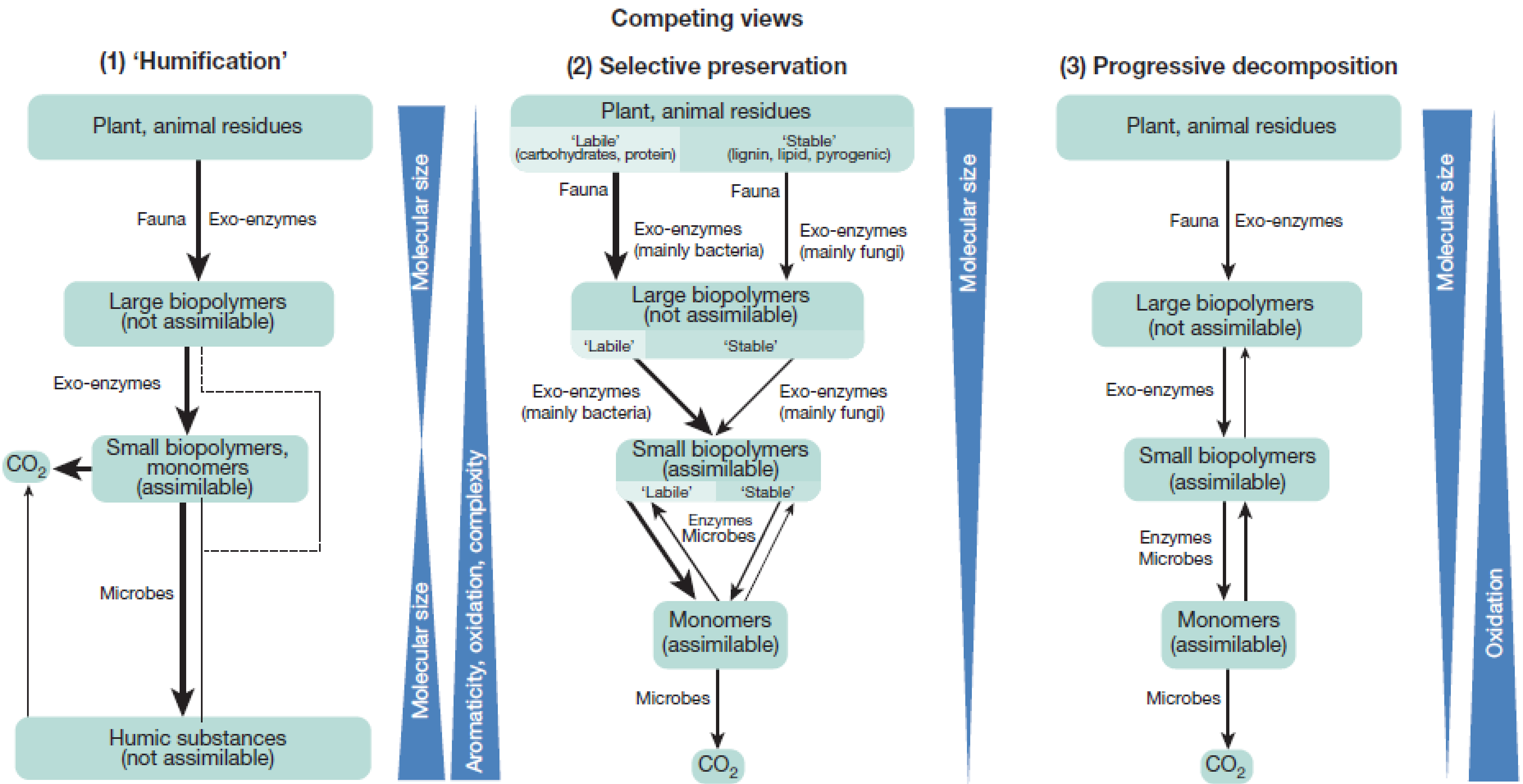
Lehmann, J., Kleber, M. (2015) The contentious nature of soil organic matter. , Vol 5 2 8 | Nature | 60-68



Reconciliation of current conceptual models for the fate of organic debris into a consolidated view of a SCM of organic matter cycles and ecosystem controls in soil. Classic 'humification' relies on the synthesis of large molecules from decomposition products. Selective preservation assumes that some organic materials are preferentially mineralized, leaving intrinsically 'stable' decomposition products behind.

Lehmann, J., Kleber, M. (2015) The contentious nature of soil organic matter. , Vol 5 2 8 | Nature | 60-68

bofru
www.bodenfruchtbarkeit.org

Im Rahmen des Bodenfruchtbarkeitsprojekts „Steigerung der Wertschöpfung ökologisch angebauter Marktfrüchte durch Optimierung des Managements der Bodenfruchtbarkeit", das vom Bundesprogramm Ökologischer Landbau gefördert wird.

Wie müde ist mein Boden?

Prognosemethode, um das Risiko eines Misserfolges beim Erbsen- oder Bohnenanbau einzuschätzen

Das Problem:

Bodenmüdigkeit kann zu schlechten Erträgen bei Erbsen und Bohnen führen. Für den Landwirt ist es schwierig, dieses Risiko im Voraus abzuschätzen. Der vorgestellte Prognosetest kann bei der Schlagauswahl helfen.

Eine repräsentative Bodenprobe ist entscheidend für aussagekräftige Ergebnisse.

Die Prognosemethode ist relativ einfach und kann mit bescheidenem Aufwand durchgeführt werden.

Das Konzept:

Rund zwei Monate vor der Saat nimmt der Landwirt Bodenproben in den Schlägen, die für eine Erbsen- oder Bohnenkultur in Frage kommen.

Mit einem einfachen Pflanzentest beurteilt er den Grad der Bodenmüdigkeit seiner Böden.

Anhand dieser Ergebnisse entscheidet er, in welchem Schlag er Erbsen oder Bohnen säen wird.

Praktische Durchführung des Tests:

Pro Schlag wird eine repräsentative Probe genommen (ca. 20 Liter, 10 mm gesiebt). Davon werden:

- vier Liter unbehandelt gelassen
- vier Liter mit Aktivkohle
- vier Liter aufgedüngt
- vier Liter über Nacht in den Ofen gestellt, bei 70-100°C.

Pro Verfahren werden vier Töpfe gefüllt, und Erbsen bzw. Bohnen angesät. Der Unterschied zwischen dem unbehandelten Boden und den übrigen Verfahren zeigt das Mass der Bodenmüdigkeit in drei Klassen an: Anbau unproblematisch, bedingtes Risiko, oder erhebliches Risiko.

unbehandelt | + Nährstoffe | + Aktivkohle | + Hitzebehandlung

Die Prognosemethode zeigt deutlich den Unterschied zwischen gesunden Böden (oben), Böden mit leichten Ermüdungserscheinungen (Mitte) und stark ermüdeten Böden (unten).

Haben Sie Fragen?

Ihre Ansprechpartner zum Thema Prognosemethode sind Lucius Tamm und Jacques Fuchs vom FiBL in Frick (CH)

unbehandelt | + Nährstoffe | + Aktivkohle | + Hitzebehandlung

Die Prognosemethode zeigt deutlich den Unterschied zwischen gesunden Böden (oben), Böden mit leichten Ermüdungserscheinungen (Mitte) und stark ermüdeten Böden (unten).

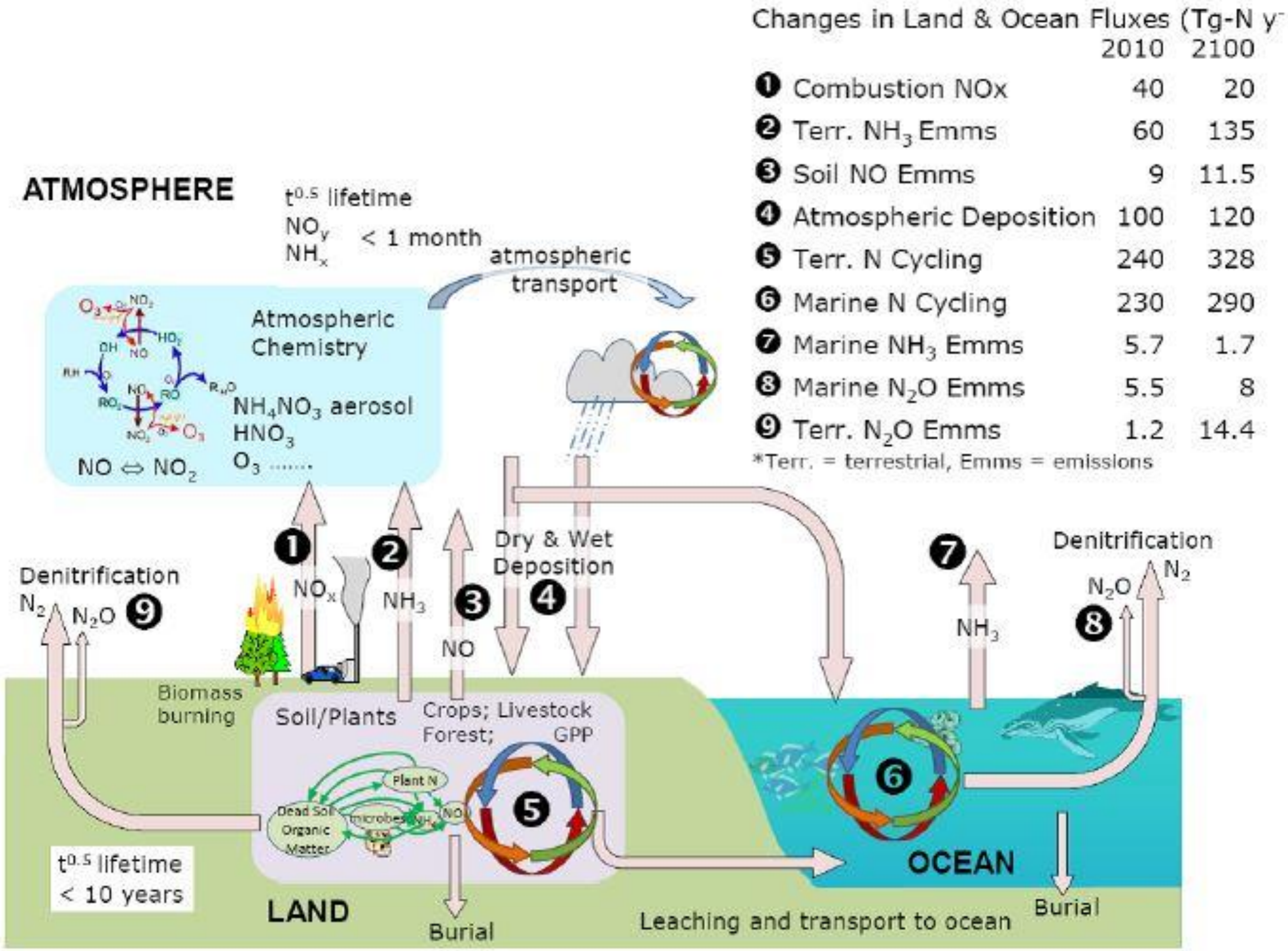


Figure 15. Changes in the major fluxes and in the terrestrial, marine and atmospheric processing of reactive nitrogen (N_r) between 2010 and 2100, adapted from Fowler et al., 2013).

Atmos. Chem. Phys., 15, 13849–13893, 2015
www.atmos-chem-phys.net/15/13849/2015/
doi:10.5194/acp-15-13849-2015

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Effects of global change during the 21st century on the nitrogen cycle

D. Fowler[1], C. E. Steadman[1,2], D. Stevenson[2], M. Coyle[1], R. M. Rees[3], U. M. Skiba[1], M. A. Sutton[1], J. N. Cape[1], A. J. Dore[1], M. Vieno[1,2], D. Simpson[4,12], S. Zaehle[5], B. D. Stocker[6], M. Rinaldi[7], M. C. Facchini[7], C. R. Flechard[8], E. Nemitz[1], M. Twigg[1], J. W. Erisman[9], K. Butterbach-Bahl[10], and J. N. Galloway[11]

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