



БИОРАЗНООБРАЗИЕ ПОЧВ И ЭКОСИСТЕМНЫЕ ФУНКЦИИ

Ю.А. Мазей

Московский государственный университет имени М.В.Ломоносова

Москва, 23 апреля 2021 г.



СОДЕРЖАНИЕ

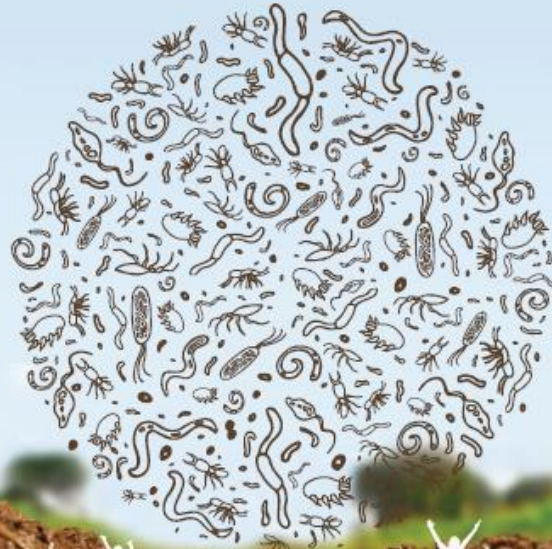
- Биоразнообразиие и экосистемные функции (BEF): *основы концепции*
- Биоразнообразиие почв: *основные представители*
- Экосистемные функции почвенного биоразнообразииа: *открытые вопросы*
- Почвенные протисты и экосистемные функции: *примеры*



Food and Agriculture
Organization of the
United Nations

Report
2020

STATE of KNOWLEDGE of SOIL BIODIVERSITY



Status, challenges and potentialities



Convention on
Biological Diversity



European
Commission



GLOBAL
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Биоразнообразие и экосистемные функции

SCIENCE'S COMPASS

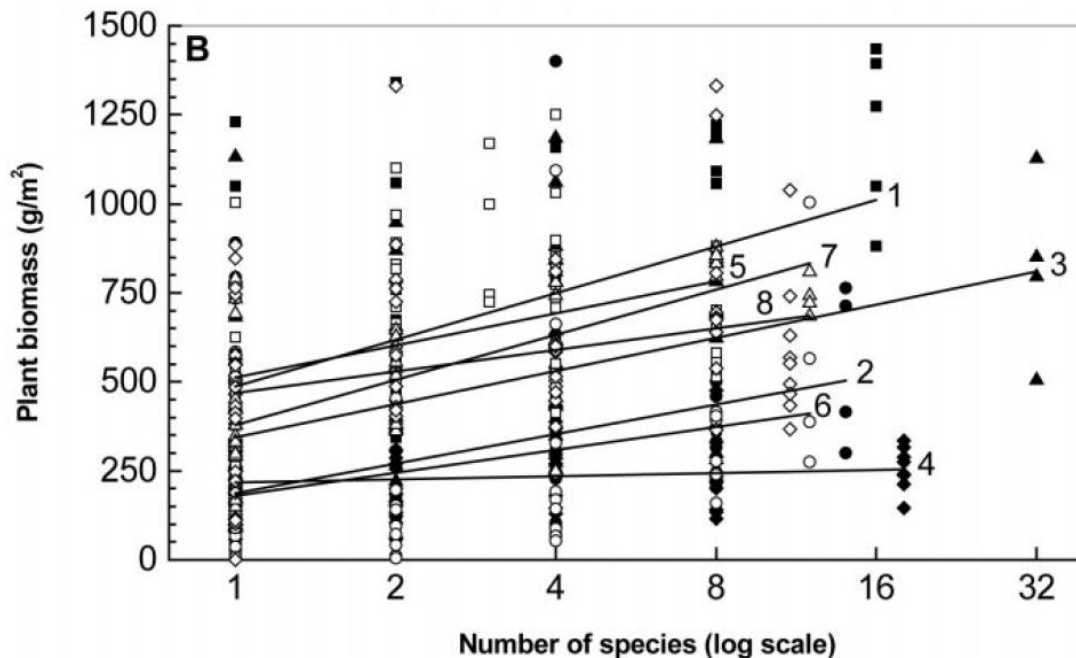


• REVIEW

REVIEW: ECOLOGY

Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges

M. Loreau,^{1*} S. Naeem,² P. Inchausti,¹ J. Bengtsson,³ J. P. Grime,⁴ A. Hector,⁵ D. U. Hooper,⁶ M. A. Huston,⁷ D. Raffaelli,⁸ B. Schmid,⁹ D. Tilman,¹⁰ D. A. Wardle⁴





Биоразнообразие и экосистемные функции

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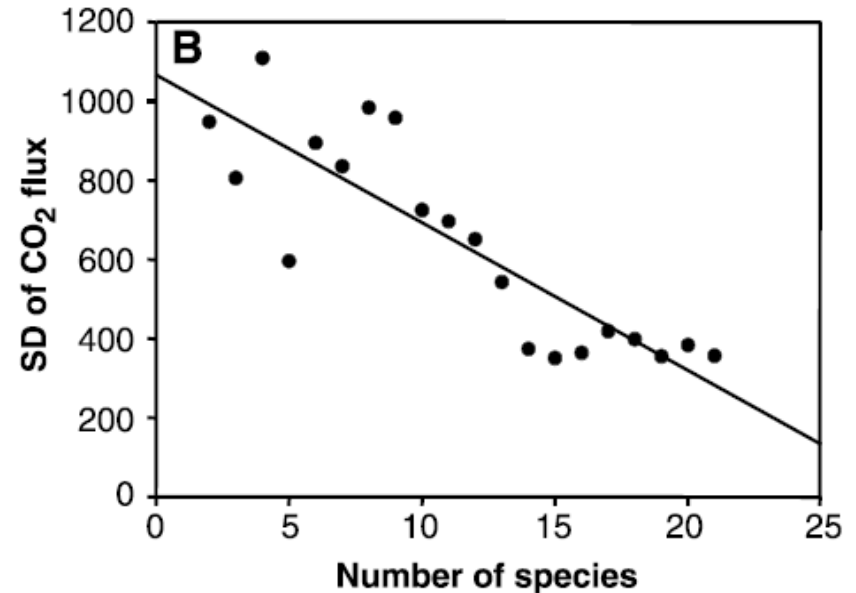
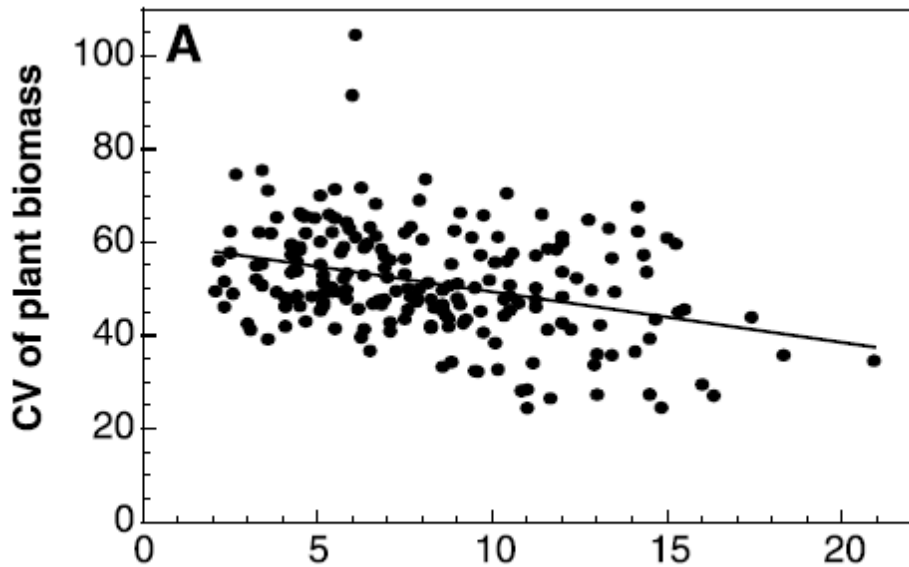


• REVIEW

REVIEW: ECOLOGY

Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges

M. Loreau,^{1*} S. Naeem,² P. Inchausti,¹ J. Bengtsson,³ J. P. Grime,⁴ A. Hector,⁵ D. U. Hooper,⁶ M. A. Huston,⁷ D. Raffaelli,⁸ B. Schmid,⁹ D. Tilman,¹⁰ D. A. Wardle⁴



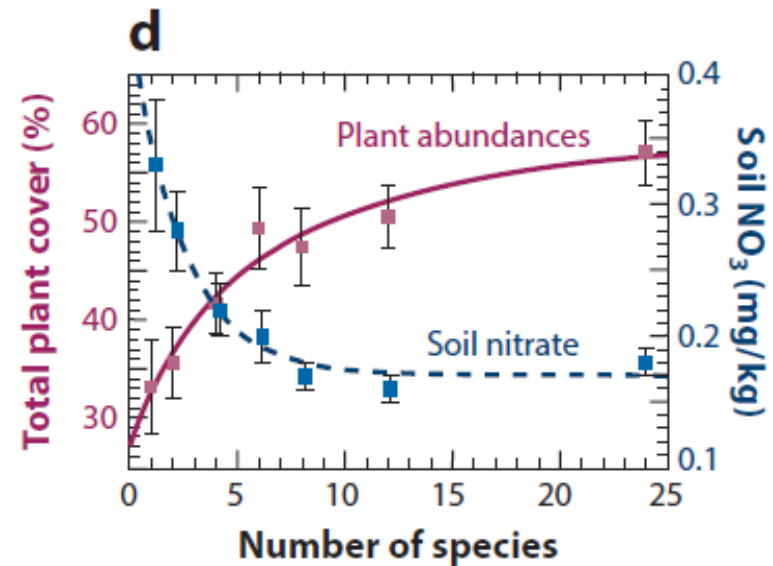
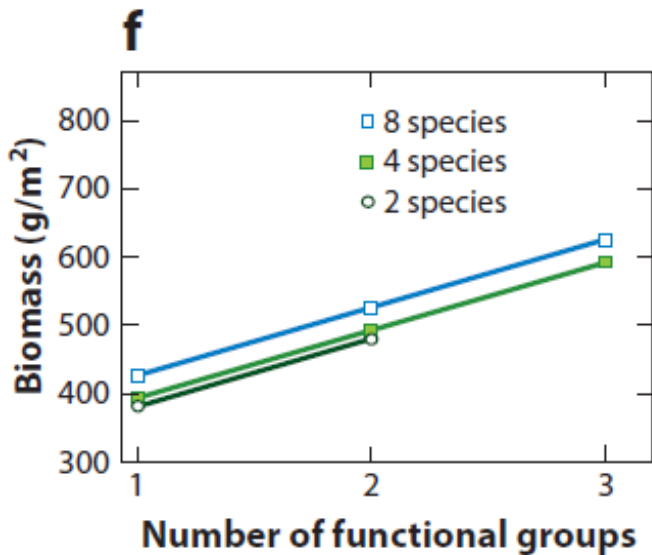
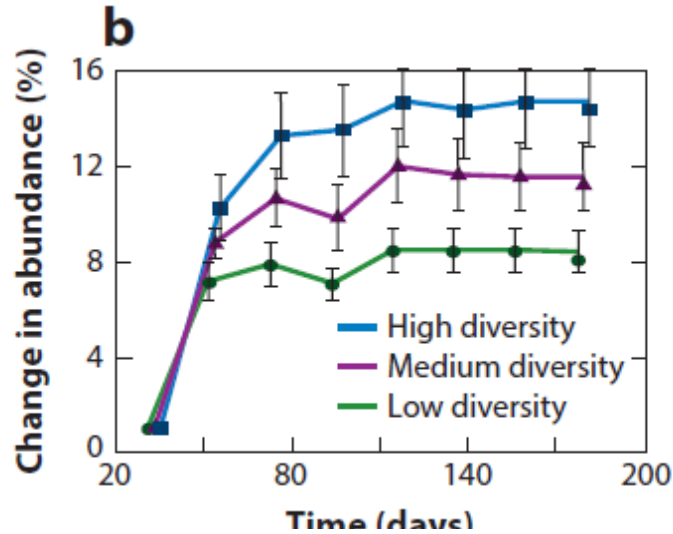


Биоразнообразие и экосистемные функции

Annu. Rev. Ecol. Evol. Syst. 2014. 45:471–93

Biodiversity and Ecosystem Functioning

David Tilman,^{1,2} Forest Isbell,^{1,3} and Jane M. Cowles¹



Belowground biodiversity and ecosystem functioning

Richard D. Bardgett¹ & Wim H. van der Putten^{2,3}





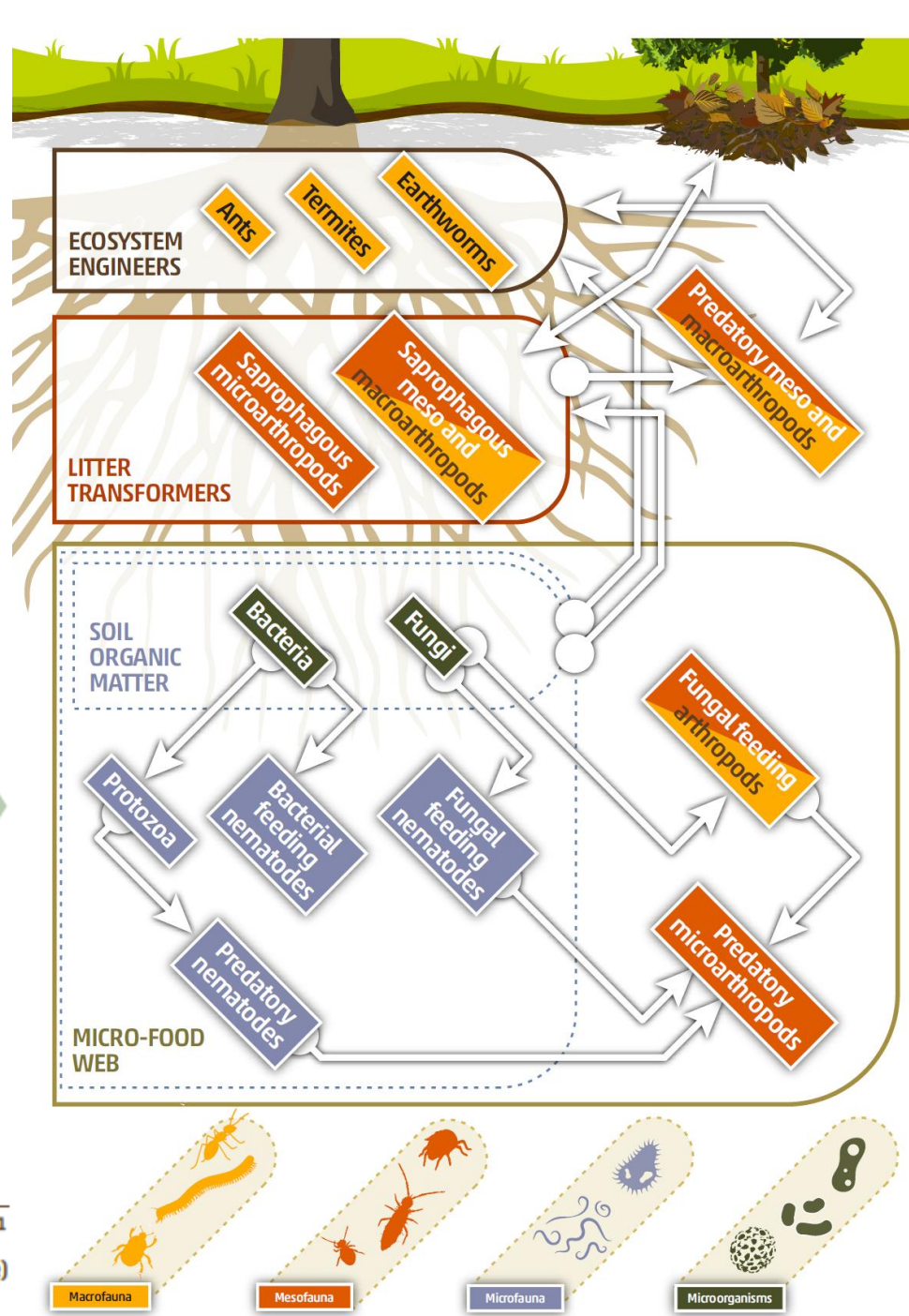
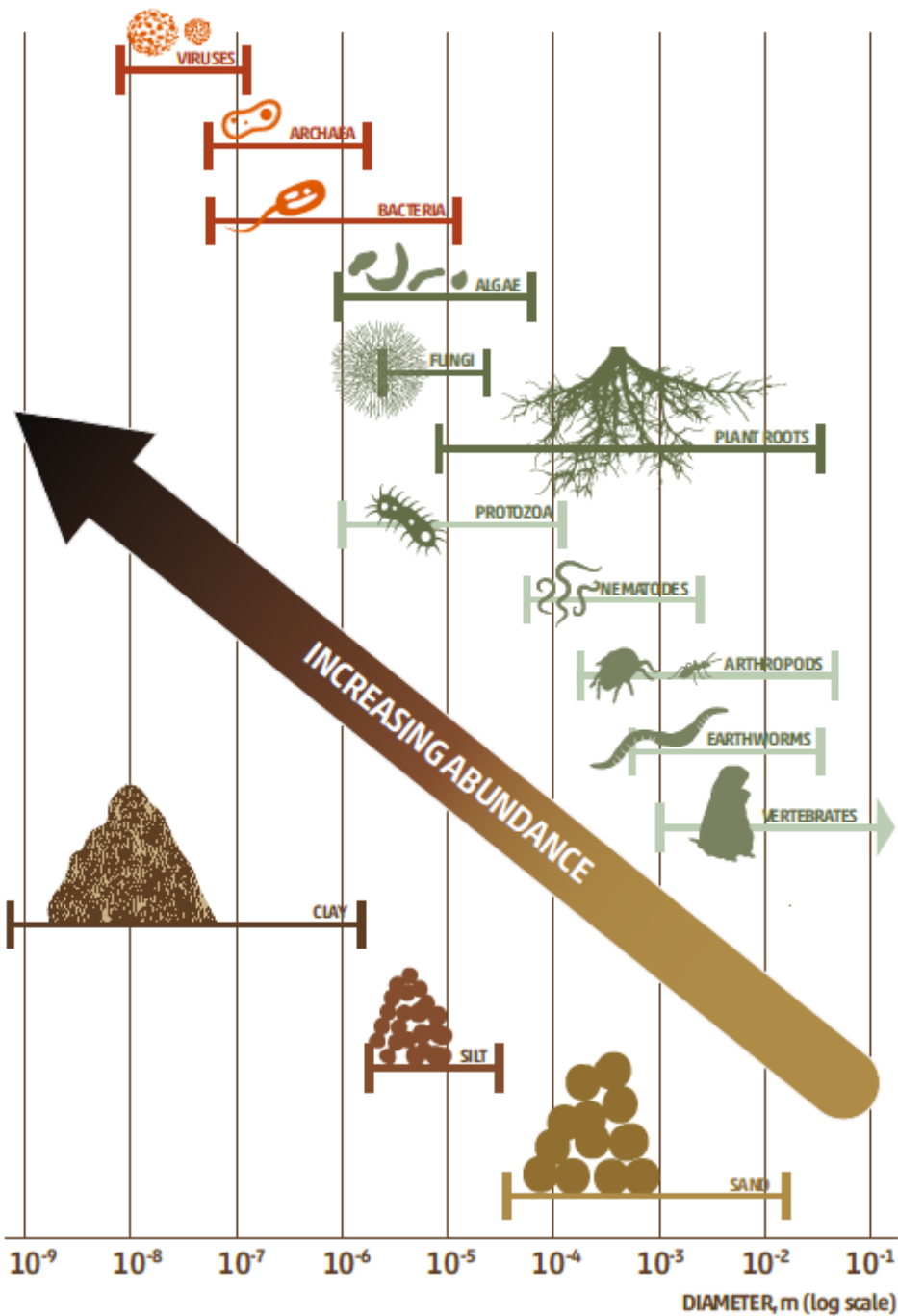
Биоразнообразие почв

Microbes including virus, bacteria, Archaea, fungi (20 nm to 10 μm) and **Microfauna** like soil protozoa and nematodes (10 μm to 0.1 mm) mostly live in soil solutions in gravitational, capillary and hygroscopic water, and participate in decomposition of soil organic matter, as well as in the weathering of minerals in the soil. Their diversity depends on the conditions of microhabitats and on the physicochemical properties of soil horizons.

Mesofauna (0.1 mm to 2 mm) are soil microarthropods (e.g., mites, springtails, enchytraeids, apterygota, small larvae of insects). They live in soil cavities filled with air and form coprogenic microaggregates, increase the surface of active biochemical interactions in the soil, and participate in the transformation of soil organic matter.

Macrofauna (2 mm to 20 mm) are large soil invertebrates (e.g., earthworms, woodlice, ants, termites, beetles, arachnids, myriapods, insect larvae). They include litter transformers, predators, some plant herbivores and ecosystem engineers, moving through the soil, thus perturbing the soil and increasing water permeability and soil aeration and creating new habitats for smaller organisms. Their faeces are hotspots for microbial diversity and activity.

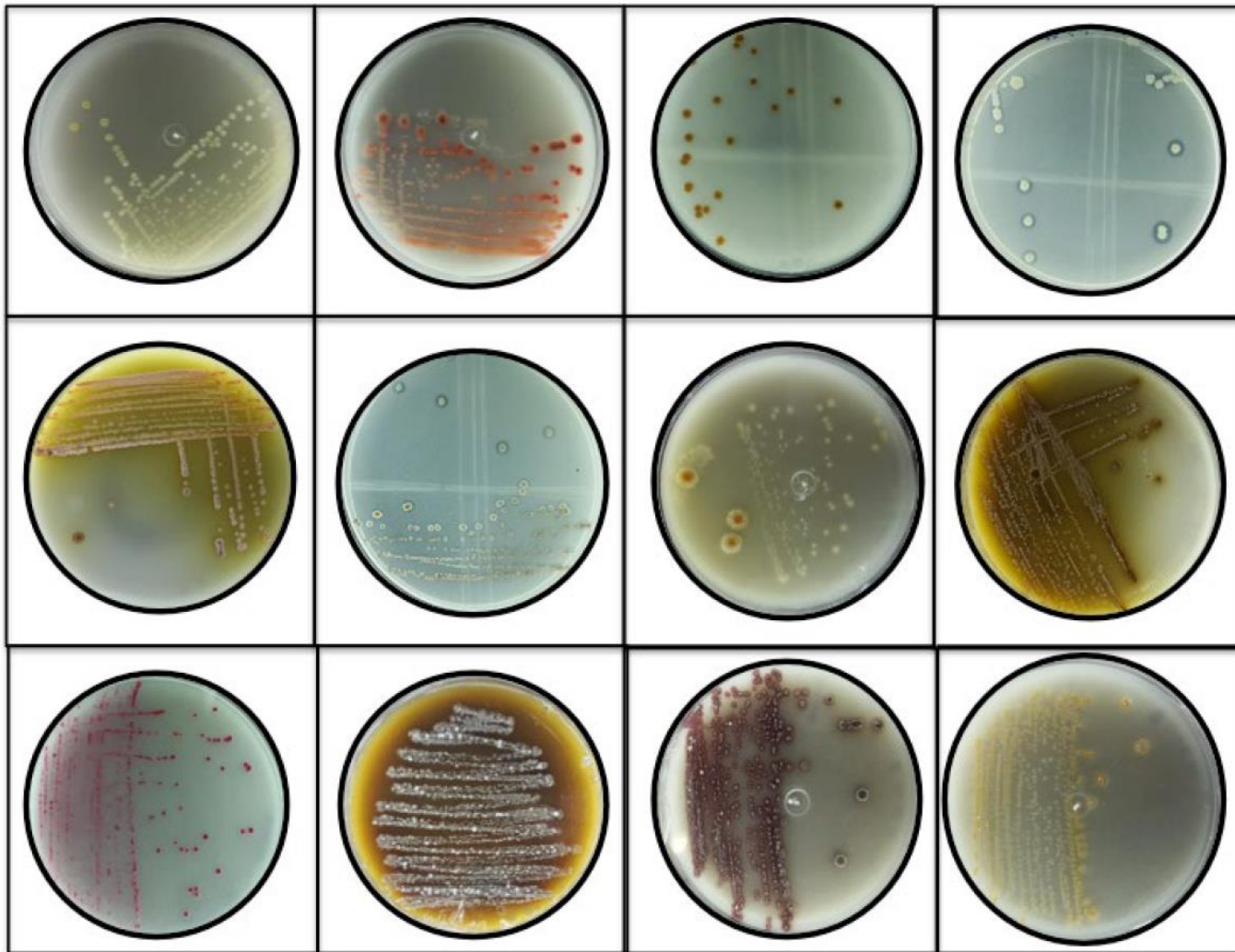
Megafauna (greater than 20 mm) are vertebrates (mammalia, reptilian and amphibia). They create spatial heterogeneity on the soil surface and in its profile through movement.





Биоразнообразие почв

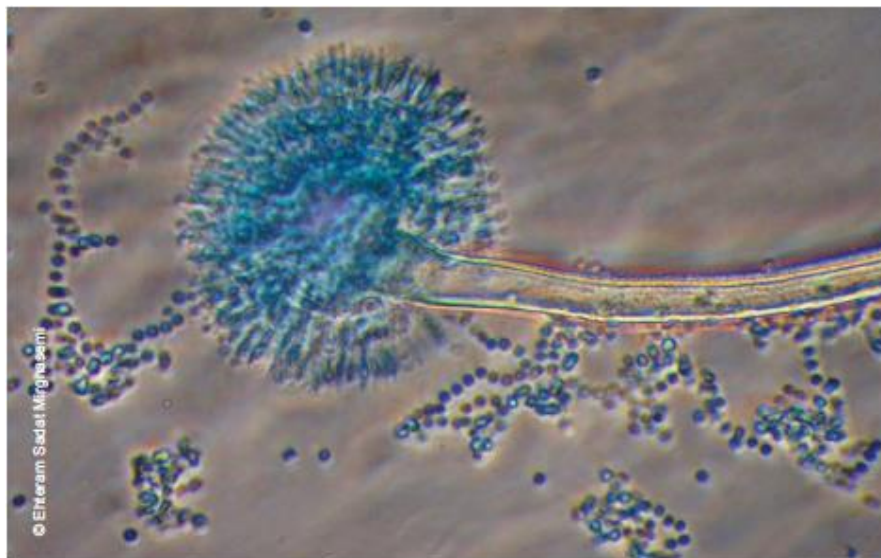
Бактерии и археи:





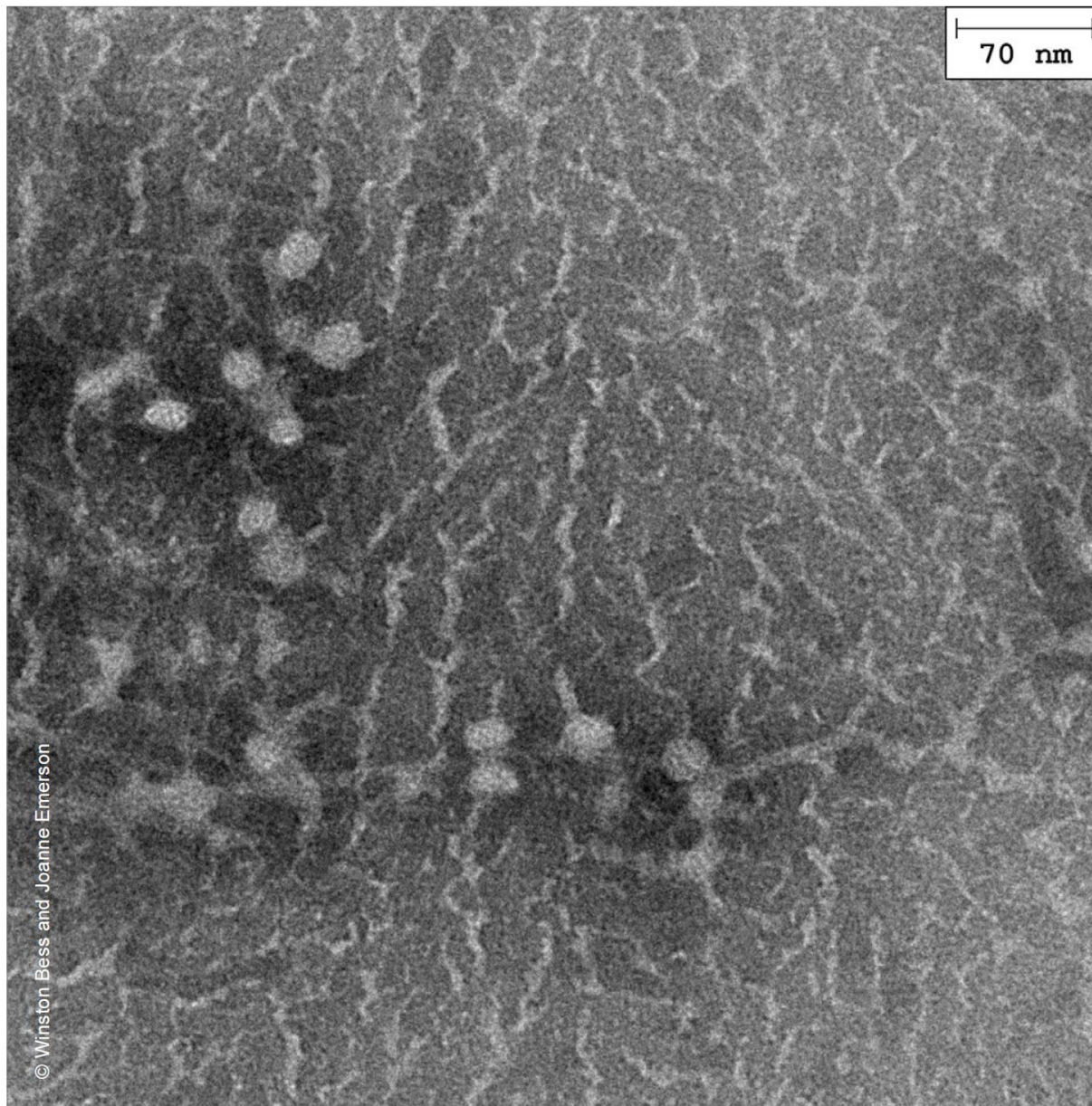
Биоразнообразие почв

Грибы:





Биоразнообразие почв



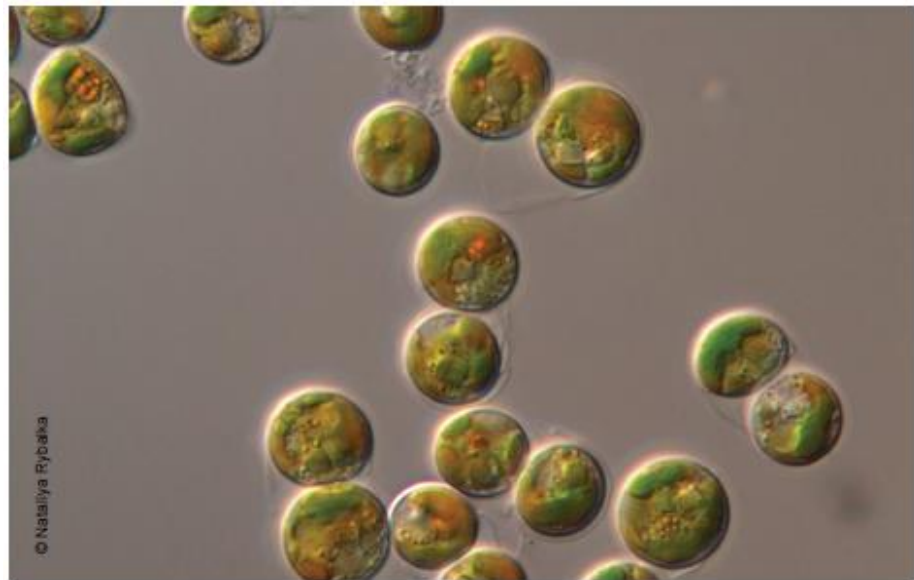
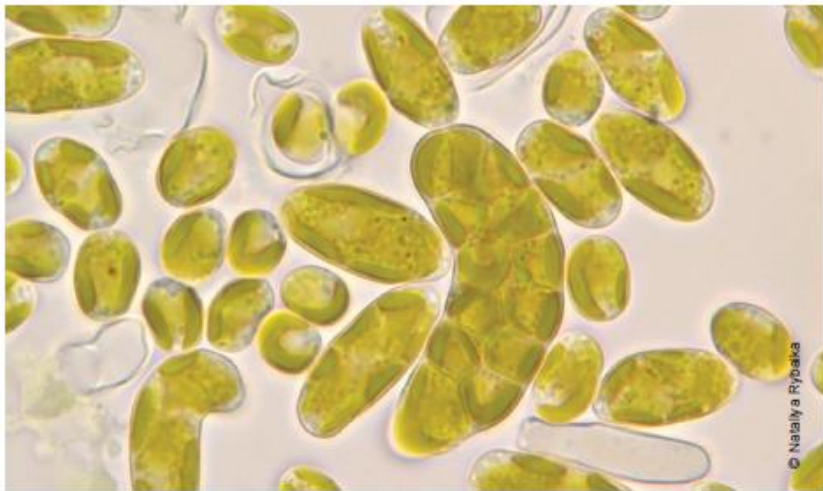
Вирусы:

© Winston Bess and Joanne Emerson



Биоразнообразие почв

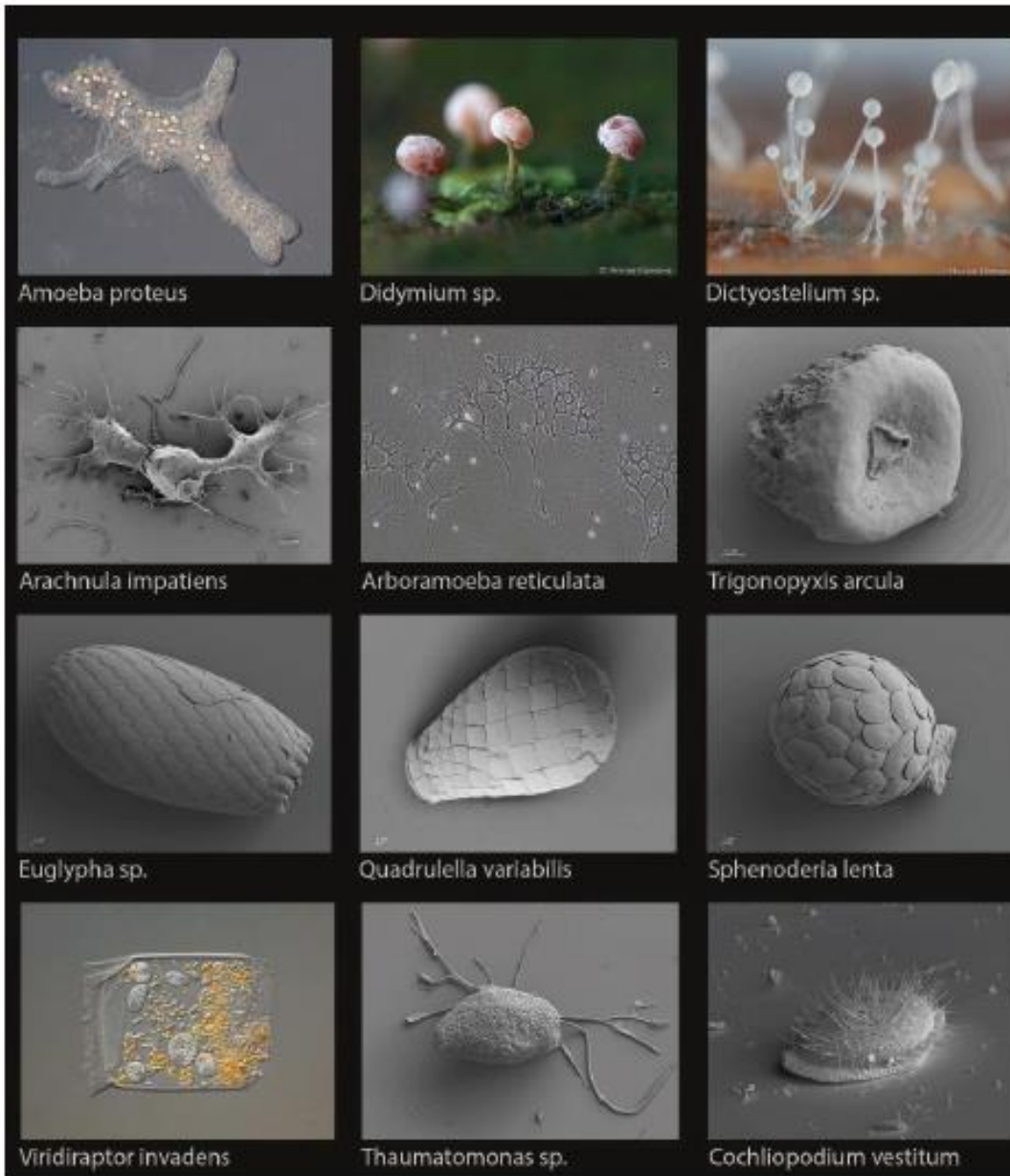
Бактерии и археи:





Биоразнообразие почв

Простейшие:





Биоразнообразие почв

Нематоды:





Биоразнообразие почв

Клещи:





Биоразнообразие почв

Коллемболы:





Биоразнообразие почв

Кольчатые черви:





Биоразнообразие почв

Изоподы, пауки, насекомые:





Биоразнообразие почв

Термиты:





Биоразнообразие почв

Муравьи:





Биоразнообразие почв

Млекопитающие:





Экосистемные функции почвенного биоразнообразия

Megafauna (e.g. moles, beavers, armadillos)	<i>Bioturbators</i> : soil, organic matter and sediment redistribution to greater depths
Macrofauna (e.g. earthworms, ants, termites, millipedes, insects)	<i>Ecosystem engineers</i> : fragment, rip, and tear organic matter, providing smaller pieces for decay by organisms; mineralization of organic matter; <i>Bioturbators</i> : moving and mixing soil, increasing water permeability and soil aeration
	<i>Bioremediation</i> : <i>Eisenia fetida</i> earthworms can accumulate cadmium and some other pollutants like polycyclic aromatic compounds (PAHs)



Экосистемные функции почвенного биоразнообразия

<p>Mesofauna (e.g. mites, springtails)</p>	<p><i>Soil modifiers:</i> all mesofauna modify the fine structure thereby changing many soil microhabitat features.</p>
<p>Microfauna (e.g. protozoa, nematodes)</p>	<p><i>Decomposers:</i> micro and mesofauna feed on dead plant material or living microbes to recycle nutrients for primary production. Thereby they modify the fine-scaled structures of soil.</p> <p><i>Food web stabilizers:</i> micro and mesofauna operate as predator and/or prey to regulate and shape soil biological communities.</p>



Экосистемные функции почвенного биоразнообразия

Microbes
(e.g. virus, bacteria and archaea, fungi)

Bioremediation: break down, removing, altering, immobilizing, or detoxifying various chemicals and physical wastes from the environment like PAHs (see chapter 5)

Decomposers: weathering minerals; Carbon transformation by decomposition of organic matter and storage, nutrient cycling by transforming inorganic compounds into forms usable by plants, regulate soil structure and pathogens

Gas producers: methanogenic archaea transfer of C, N₂, N₂O, CH₄ denitrification

Nitrogen fixers: rhizobia bacteria found on legume roots helping to increase nitrogen uptake.

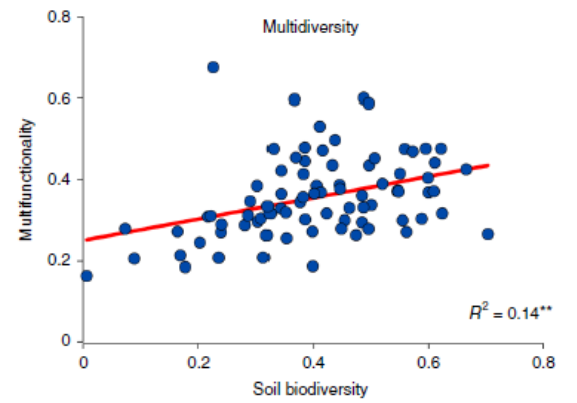
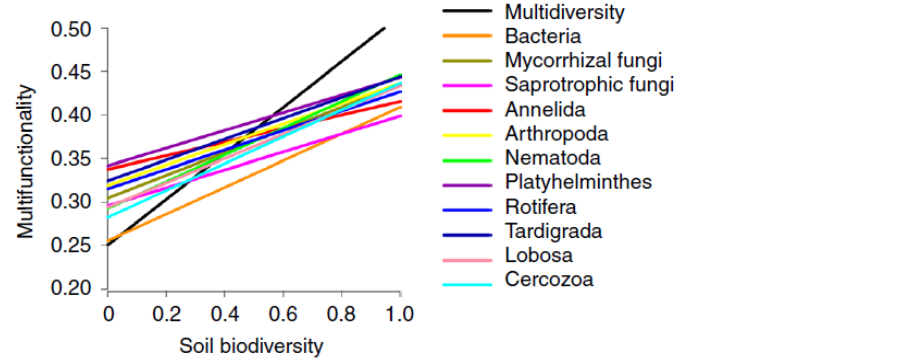
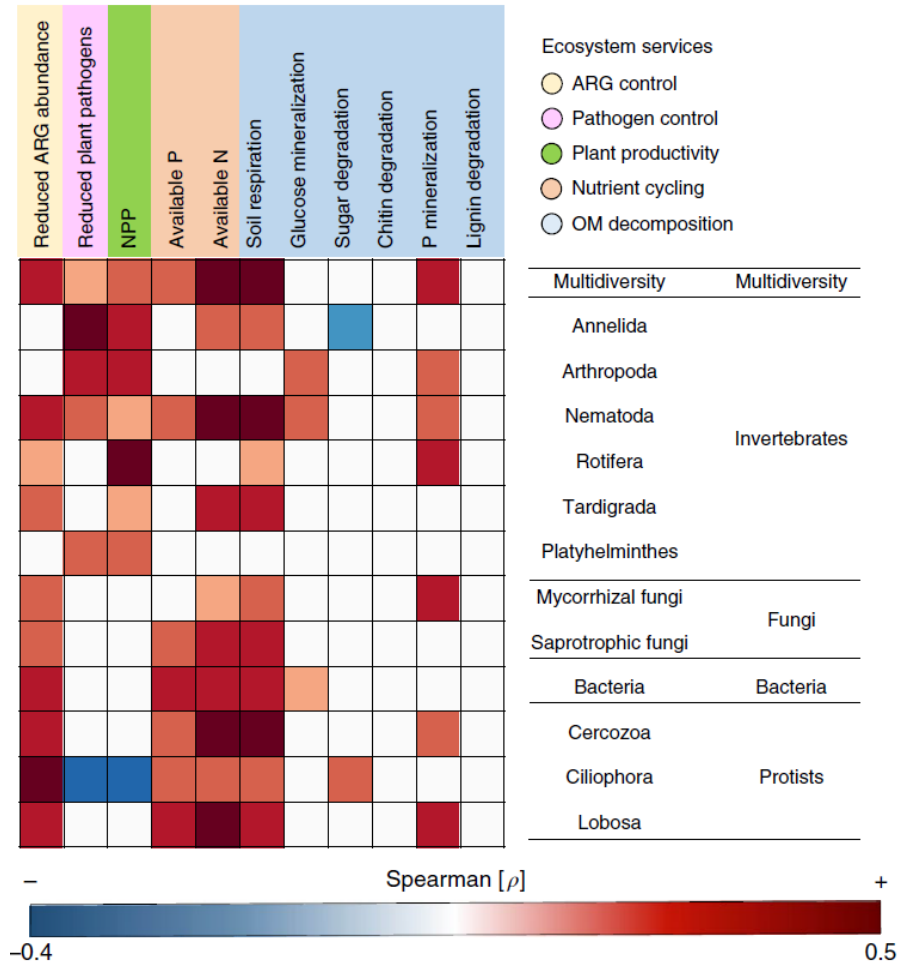


Экосистемные функции почвенного биоразнообразия

ARTICLES
<https://doi.org/10.1038/s41559-019-1084-y>
 nature ecology & evolution

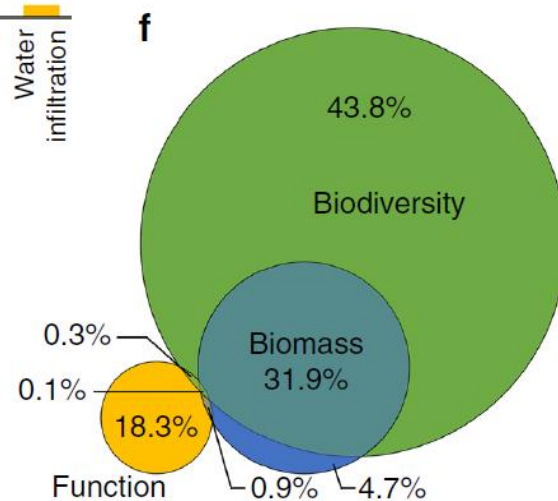
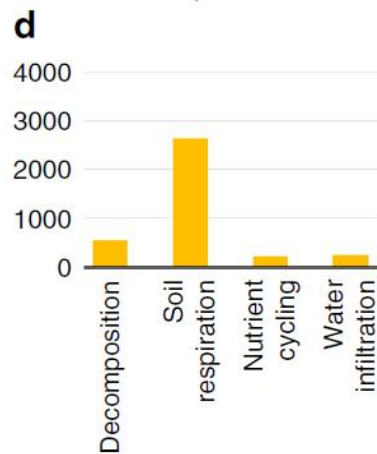
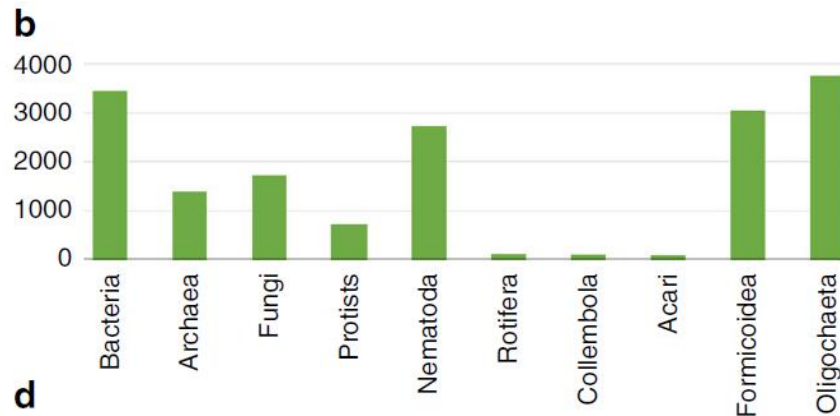
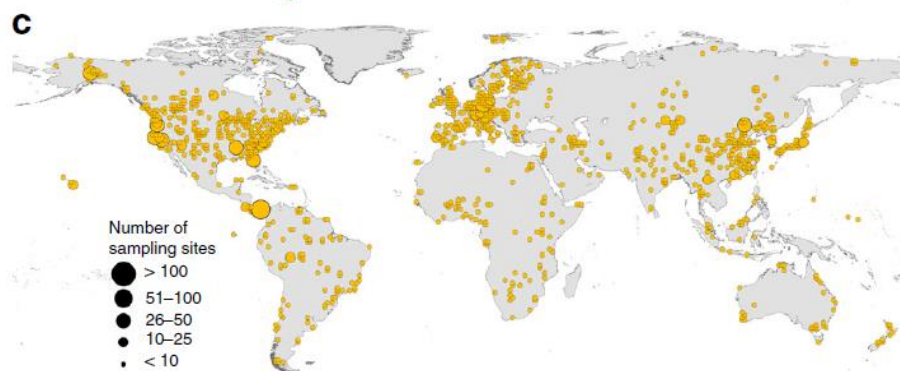
Multiple elements of soil biodiversity drive ecosystem functions across biomes

NATURE ECOLOGY & EVOLUTION | VOL 4 | FEBRUARY 2020 | 210-220 | www.nature.com/natecolevol



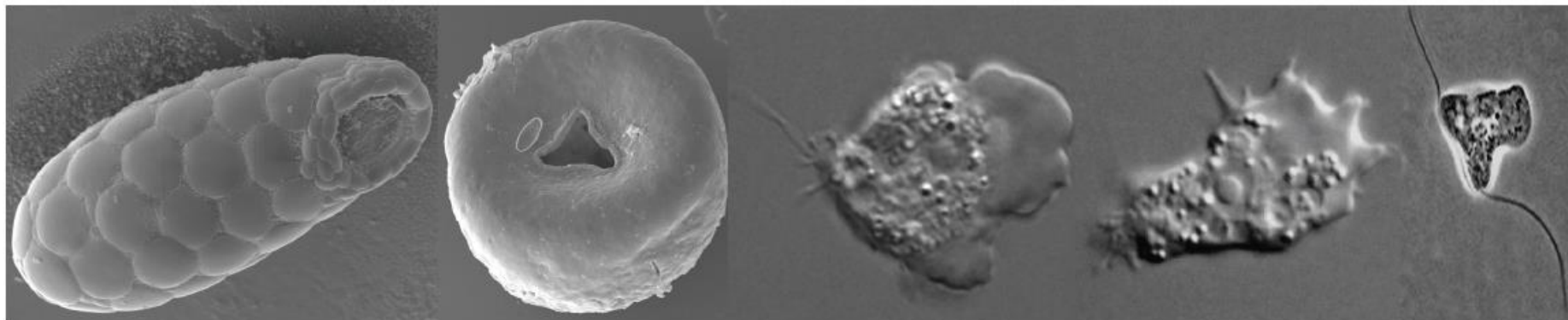


Экосистемные функции почвенного биоразнообразия





Почвенные протисты



SOIL PROTISTS

**Important part of the soil biodiversity
- now included in the GSBI -**



[Home page](#)

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Почвенная протозоология в России



АКАДЕМИЯ НАУК ЛИТОВСКОЙ ССР
ИНСТИТУТ ЗООЛОГИИ И ПАРАЗИТОЛОГИИ
ВИЛЬНЮСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
им. М. В. ЛОМОНОСОВА

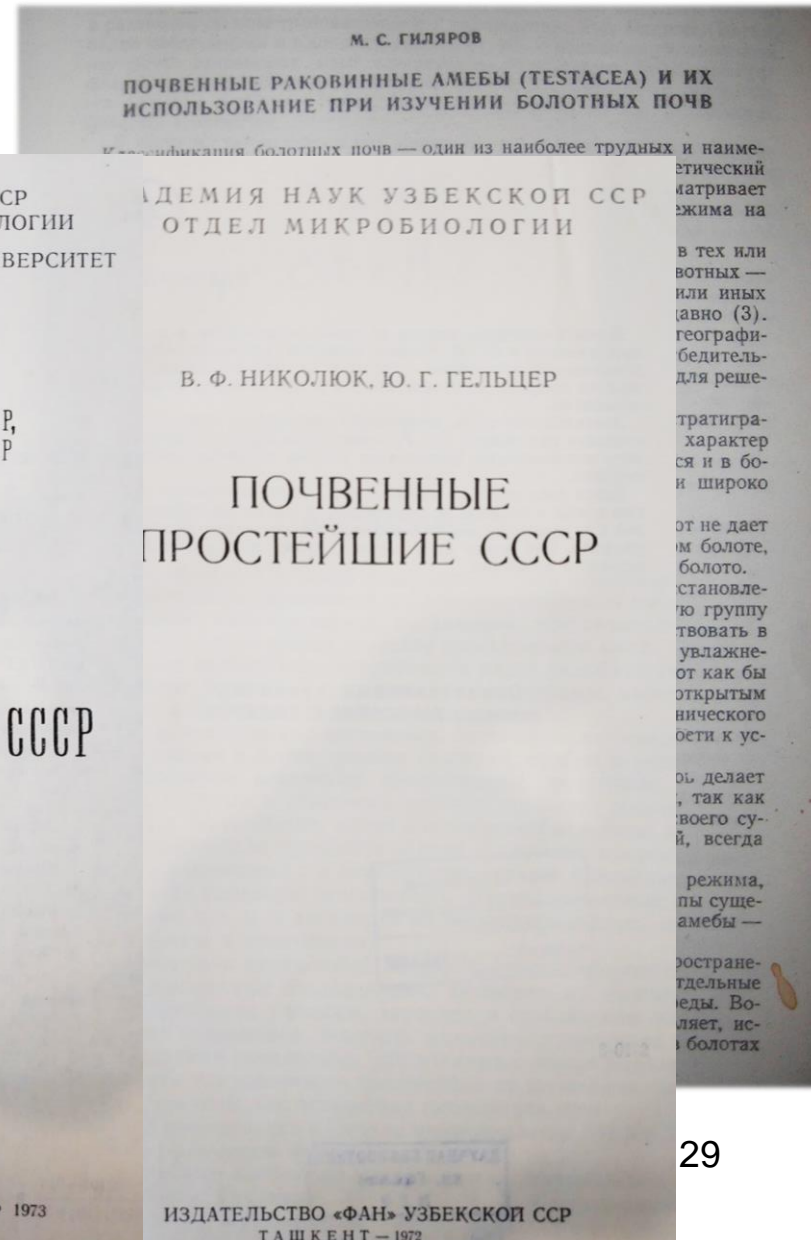
А. К. ЛЕПИНИС, Ю. Г. ГЕЛЬЦЕР,
О. И. ЧИБИСОВА, В. А. РЕПТНЕР

ОПРЕДЕЛИТЕЛЬ *PROTOZOA* ПОЧВ ЕВРОПЕЙСКОЙ ЧАСТИ ССРС

*Под общей редакцией
члена-корреспондента АН ССРС,
доктора биологических наук,
проф. М. С. Гилярова*



ИЗДАТЕЛЬСТВО «МИНТИС» • ВИЛЬНЮС • 1973





Почвенная альгология в России



Г. М. ЗЕНОВА,
Э. А. ШТИНА

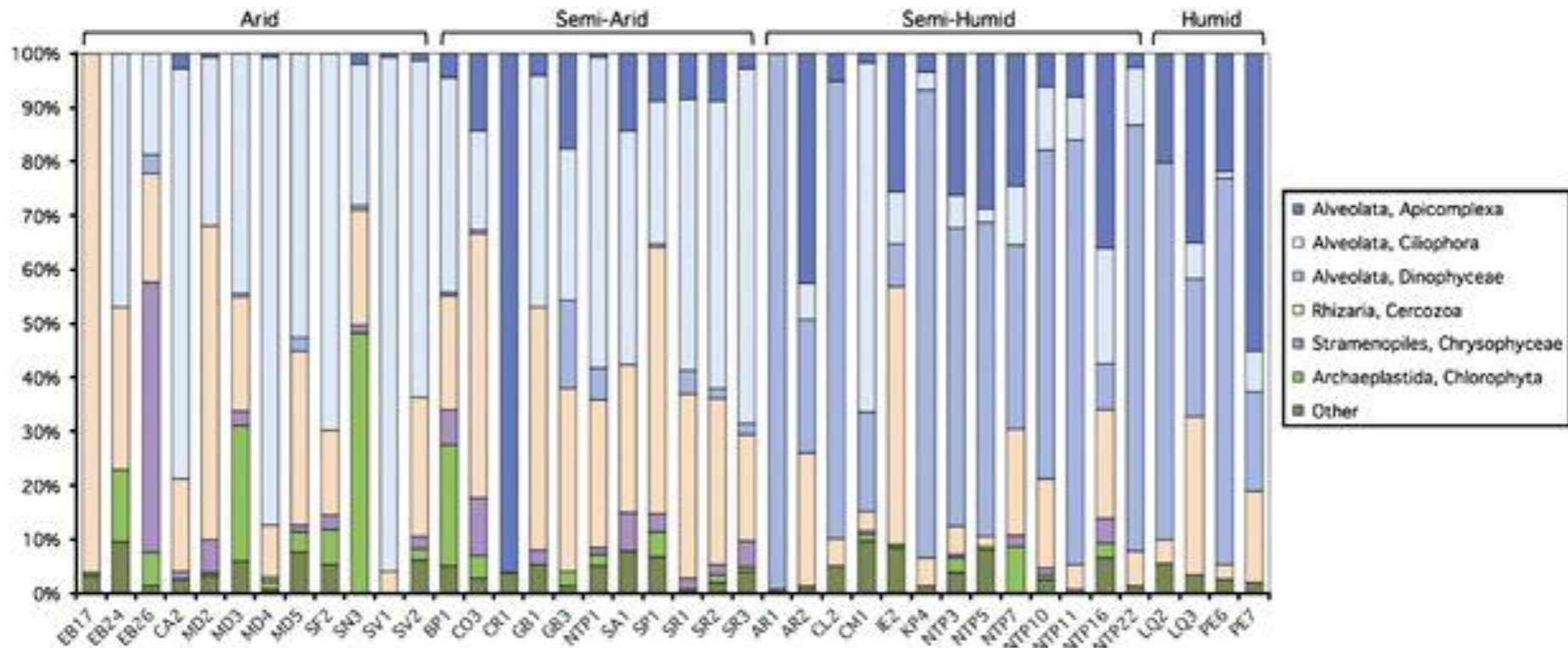
Почвенные водоросли

Издательство
Московского университета
1960





Почвенные протисты: молекулярное разнообразие



Bates et al., 2013. *ISME Journal*

Figure 1 Relative abundance of soil protistan taxa (y axis as group percentage of the total number of 18S rRNA gene sequences per sample, after rarefaction to correct for uneven sampling effort) grouped by general CMI class. Identities of the sites sampled are given on the x axis (see Supplementary Table S1 for specific details on site and soil characteristics).



Почвенные протисты: молекулярное разнообразие

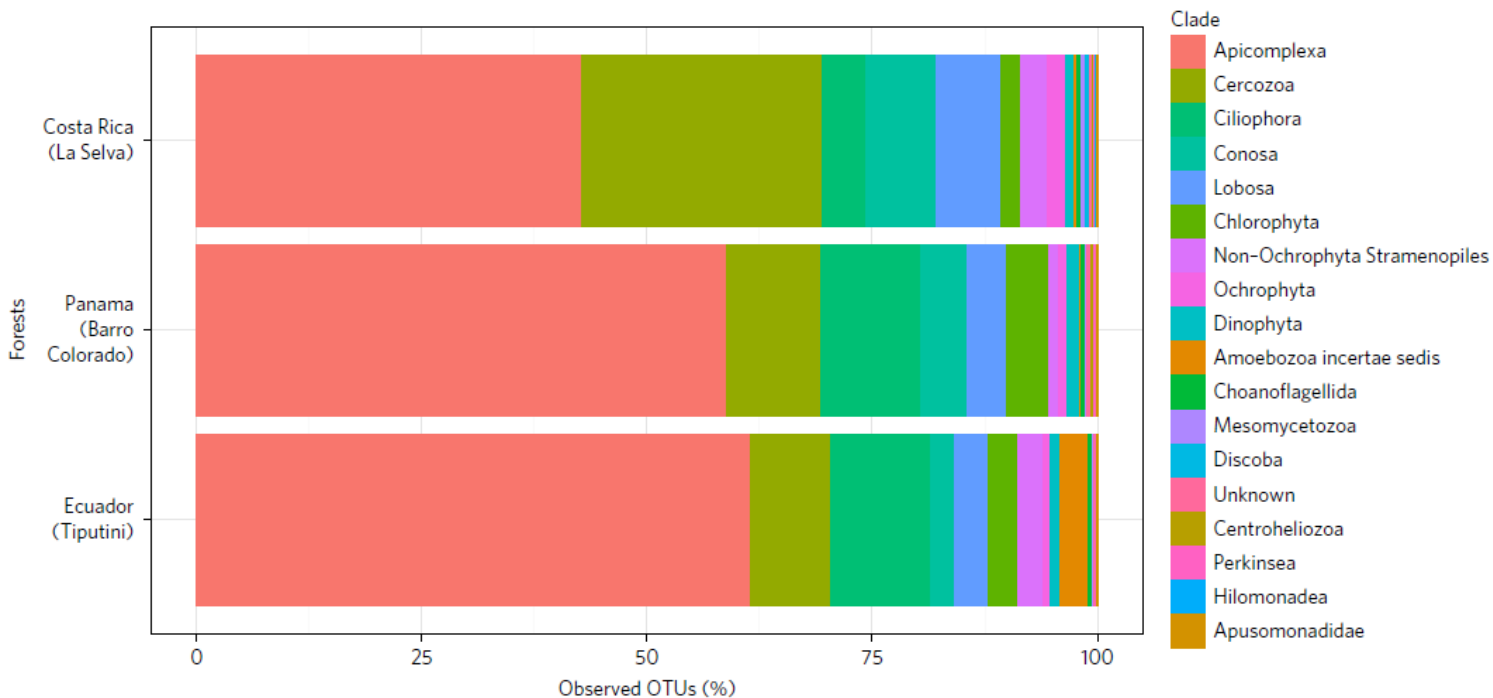
nature
ecology & evolution

ARTICLES

PUBLISHED: 20 MARCH 2017 | VOLUME: 1 | ARTICLE NUMBER: 0091

Parasites dominate hyperdiverse soil protist communities in Neotropical rainforests

Frédéric Mahé¹, Colomán de Vargas^{2,3}, David Bass^{4,5}, Lucas Czech⁶, Alexandros Stamatakis^{6,7}, Enrique Lara⁸, David Singer⁸, Jordan Mayor⁹, John Bunge¹⁰, Sarah Sernaker¹¹, Tobias Siemensmeyer¹, Isabelle Trautmann¹, Sarah Romac^{2,3}, Cédric Berney^{2,3}, Alexey Kozlov⁶, Edward A. D. Mitchell^{8,12}, Christophe V. W. Seppey⁸, Elianne Egge¹³, Guillaume Lentendu¹, Rainer Wirth¹⁴, Gabriel Trueba¹⁵ and Micah Dunthorn^{1*}

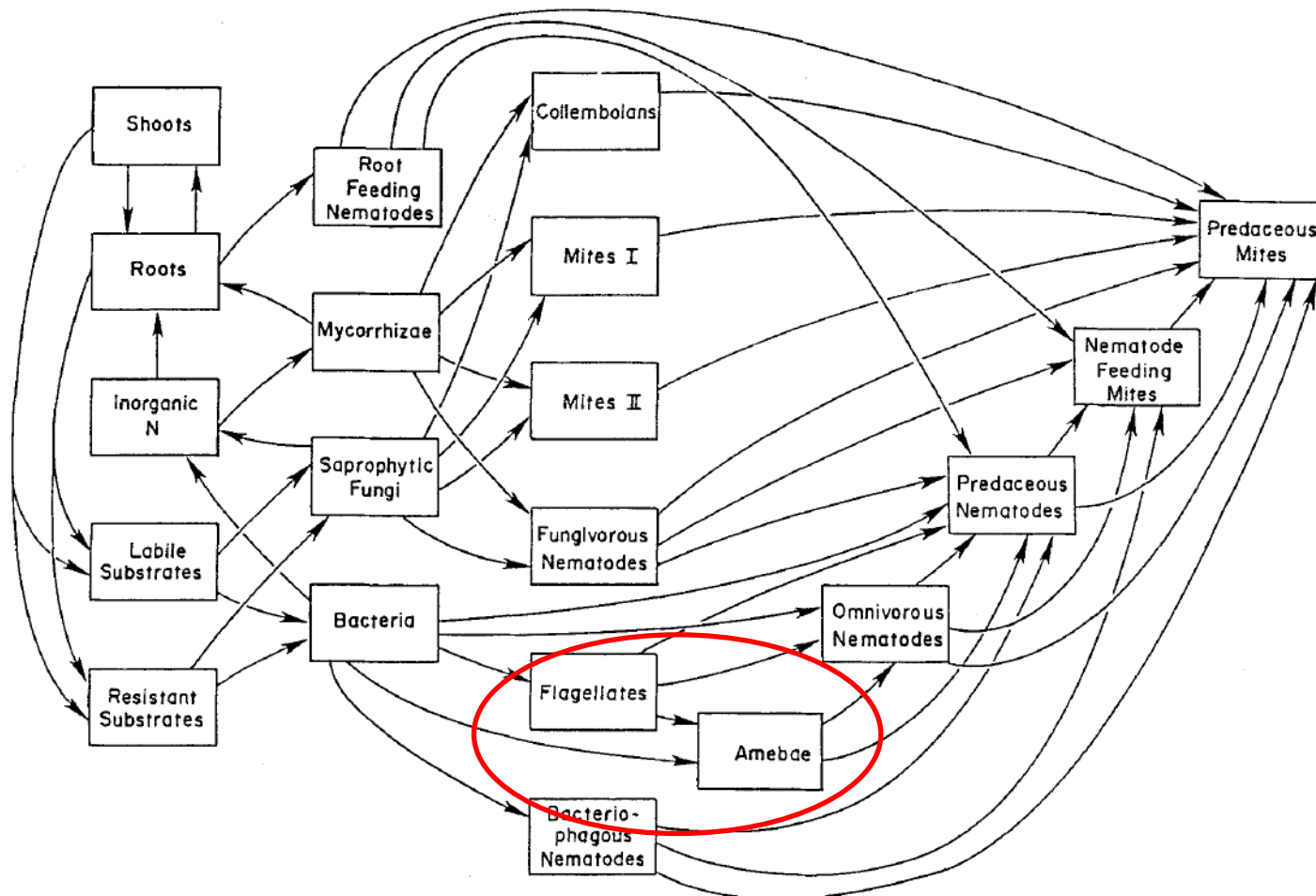


Почвенные протисты: функциональная роль

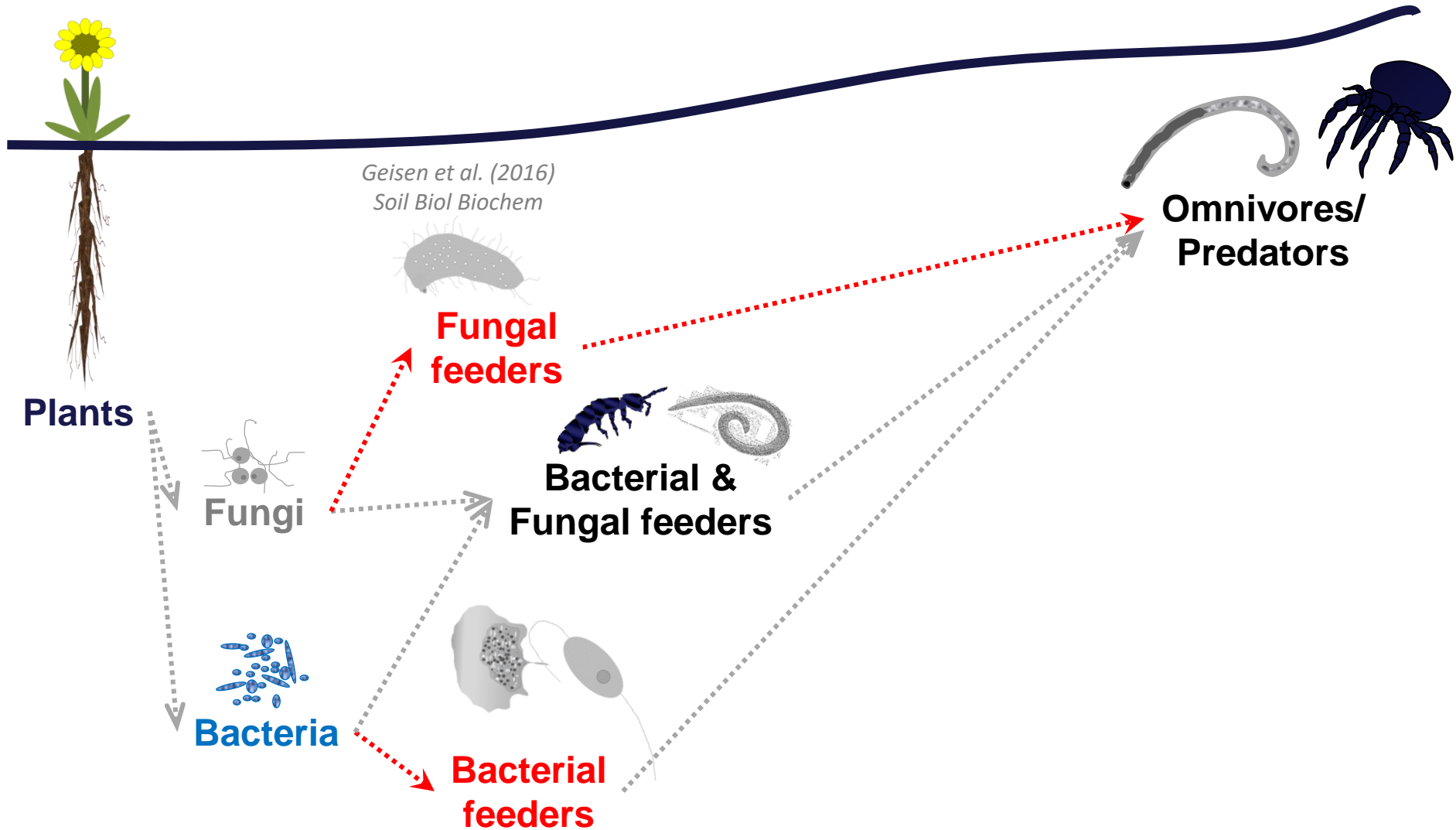
Biol Fertil Soils (1987) 3:57-68

The detrital food web in a shortgrass prairie*

H.W. Hunt¹, D.C. Coleman², E.R. Ingham³, R.E. Ingham³, E.T. Elliott¹, J.C. Moore¹, S.L. Rose⁴,
C.P.P. Reid⁵, and C.R. Morley¹



Почвенные протисты: функциональная роль

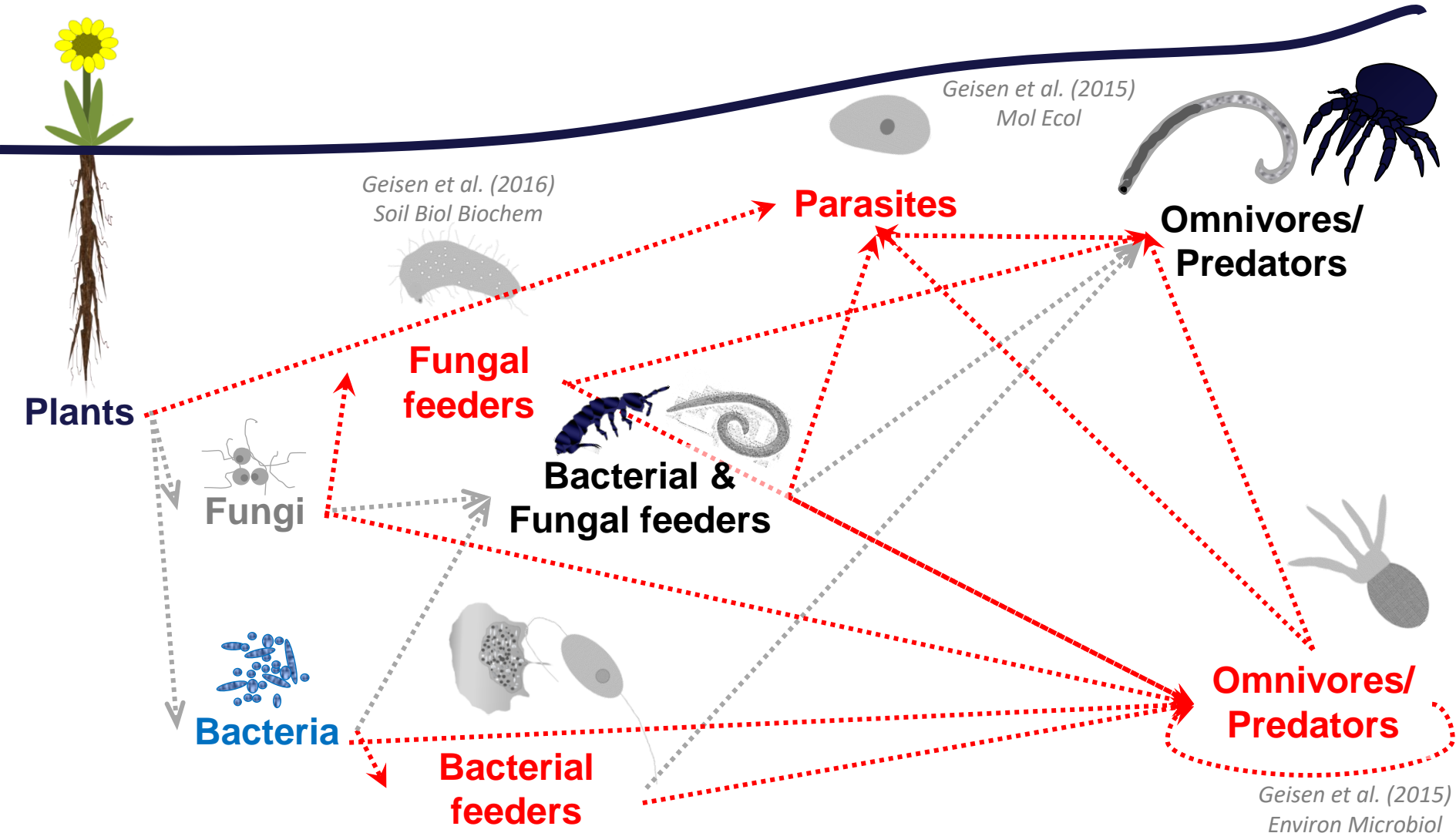


Почвенные протисты: *функциональная роль*

© S. Geisen, 2018

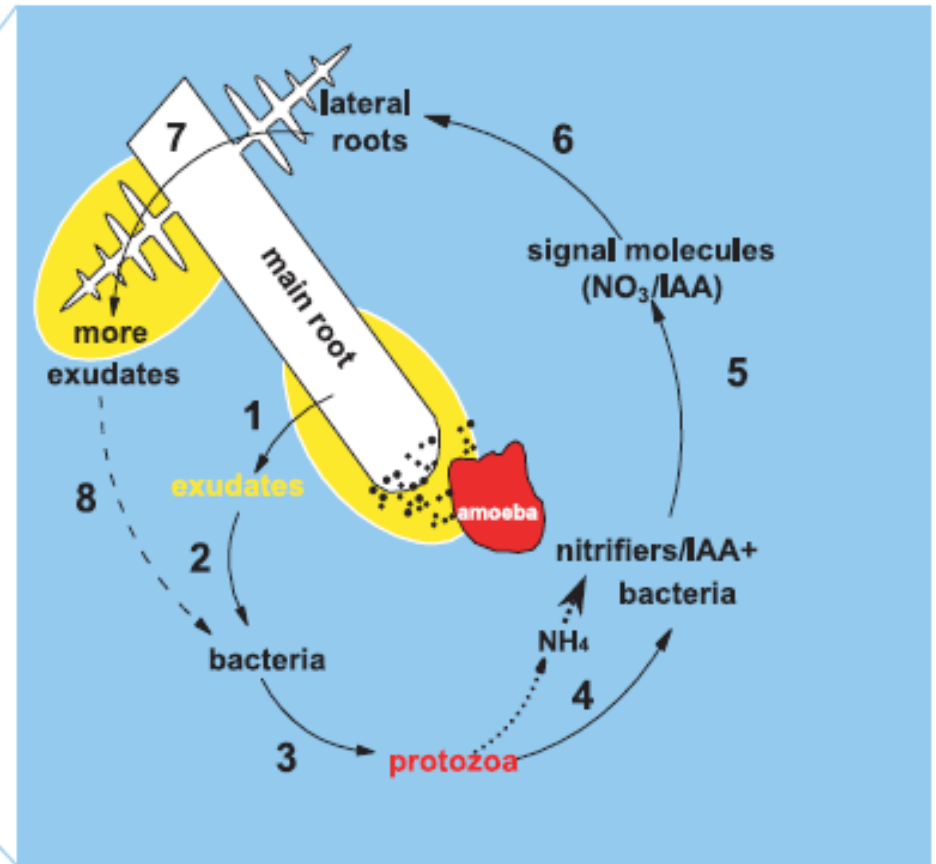
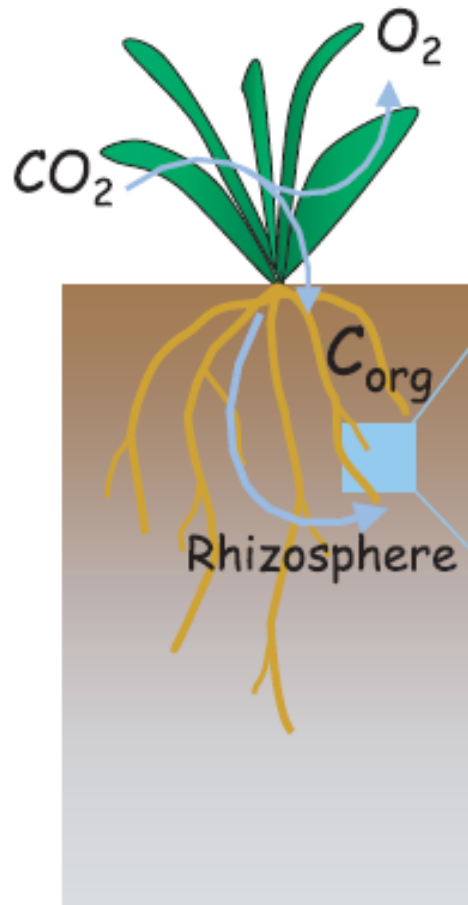


Почвенные протисты: функциональная роль



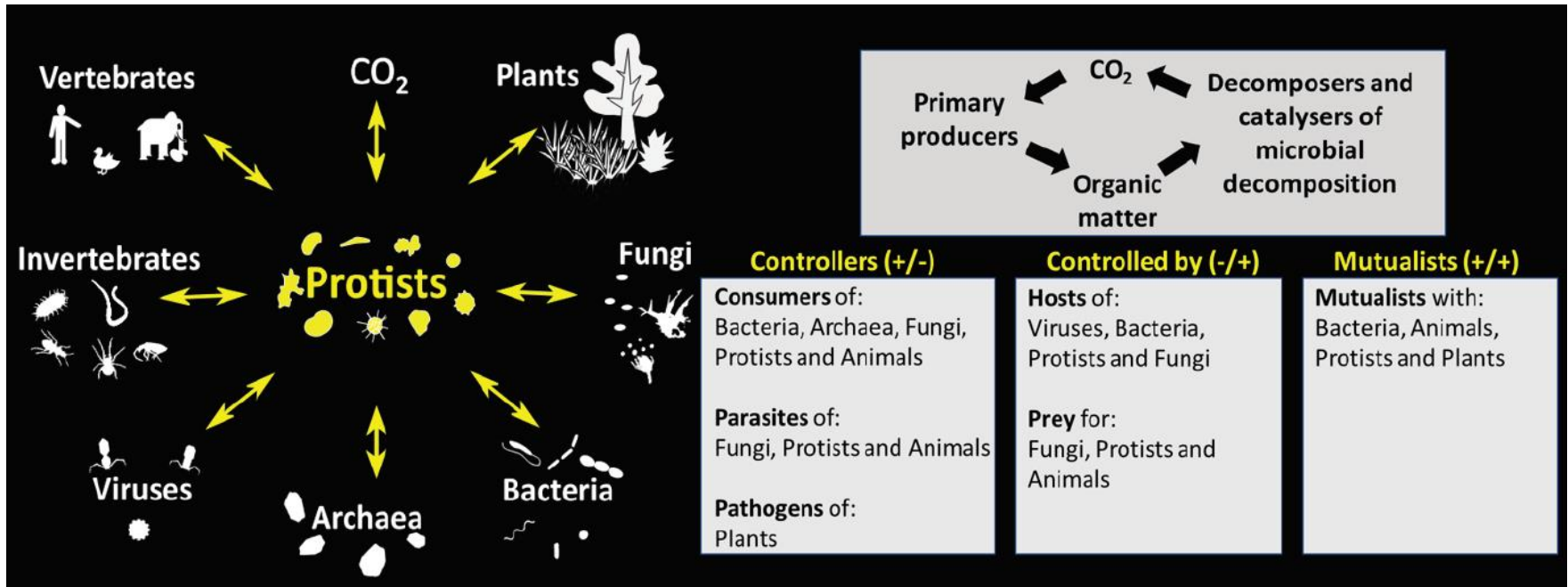
Почвенные протисты : *функциональная роль*

Bonkovski, 2004
New Phytologist



Soil protist life matters!

Stefan Geisen^{1*}, Enrique Lara², Edward A.D. Mitchell³, Eckhard Völcker⁴ and Valentyna Krashevskaya⁵





Спасибо за внимание