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Bacteria-to-Archaea ratio depending on soil depth and agrogenic impact

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Archaeal communities and their potential roles in the soil ecosystem are affected by a number of soil proprerties and environmental factors. Competitive interactions between Archaea and Bacteria play a particular role in spread and abundance of these two domains. Therefore, the goal of the study was to evaluate the Bacteria-to-Archaea ratio in different soils.

The research was carried out at field and natural ecosystems of European part of Russia. Samples were collected within the soil profiles (3-6 horizons) of chernozem and kastanozem with distinctly different agrogenic impact. In situ hybridization with fluorescently labeled rRNA-targeted oligonucleotide probes (FISH) was used to determine the abundance of metabolically active cells of Archaea and Bacteria. The Cmic, Corg, C/N, DNA content and growth characteristics have been analyzed as well.

Determination of number of metabolically active cells in chernozem under arable land and forest revealed that abundance of Archaea in topsoil under forest was higher more than 2 times comparing with arable land, but leveled off in the deeper horizons. Plowing of Chernozem decreased amount of archaeal and bacterial active cells simultaneously, however, Bacteria were more resistant to agrogenic impact than Archaea.

Determination of the taxonomic composition within Bacteria domain showed a significant decrease in the abundance of phylogenetic groups Firmicutes and Actinobacteria in the topsoil under arable land comparing to the forest, which is the main reason for the declining of the total amount of prokaryotic cells.

In kastanozem significant change in the number of metabolically active cells due to plowing was detected only within 40 cm soil layer, and this effect disappeared in lower horizons. The number of Archaea was higher in the upper horizons of arable as compared to virgin soil. Conversely, the number of Bacteria in the upper layers of the soil after plowing kastanozem decreased.

Relationship between soil organic carbon content and the amount of soil metabolically active Bacteria and Archaea cells revealed that distribution of both Bacteria and Archaea throughout the soil profile was governed by organic matter content. Thus, the organic matter content seemed to be the main factor of declining Bacteria-to-Archaea ratio down the profile (from 7.1 to 4.2 for virgin soil and from 5 to 3.9 for arable soil). In conclusion, Archaea out-compete Bacteria under conditions of reduced energy supply.