

Olga LOPATOVSKAYA, Anna SEREDKINA and Natalia BELKOVA. 2014. Effect of Ecological Factors on the Distribution of Microorganisms in Regosols (Steppe of Priol'khonie, Siberia). *Acta Geologica Sinica* (English Edition), 88 (supp. 1): 188-190.

Effect of Ecological Factors on the Distribution of Microorganisms in Regosols (Steppe of Priol'khonie, Siberia)

Olga LOPATOVSKAYA¹, Anna SEREDKINA¹ and Natalia BELKOVA^{1,2}

¹ Irkutsk State University, Irkutsk, 664003, Russia;

² Limnological Institute of the Siberian Branch of the Russian Academy of Sciences, Irkutsk, 664033, Russia

1 Introduction

Regosol in Eastern Siberia is intrazonal soil. In Priol'khonie region it occurs among chestnut soils, salt marshes and solonchaks. There are small information about Tagotskij hydrolaccolith in the research articles of geologists, archaeologists, and paleolimnologists when describing geological deposits and paleoclimate reconstruction (Popova et al., 1989). Some physical and chemical properties of soils have been determined by the authors. Additionally attempts have been done to reveal the peculiarities of the lake sediment evolution, but not to describe the soil and its physicochemical properties (Vorobieva, 2011; Mats et al., 2001). At present it is possible to update existing data in order to obtain a more detailed characterization of soil those are unique to the region by modern research approaches.

Soil microbial communities are interesting by a range of interesting biogeochemical functions. They play an important role in the cycle of organic matter, pedogenesis, and the formation of soil fertility. A great variety of living organisms could be found in soil ecosystems, both prokaryotes (bacteria, actinomycetes, blue-green algae) and eukaryotes (fungi, micro algae, protozoa). New species of microorganisms differ in their physiological and biochemical properties (pH optimum, respect to temperature, osmotic pressure, the sources of organic and inorganic substances used for metabolism) have been isolated by modern approaches to cultivation. Taken into account that the soils contain huge amounts of organic matter of different origin, the investigation of heterotrophic microorganisms are of great interest.

The main aim of the present study was analysis of the ecological factors affected the formation soil with buried horizons and deposits in cryogenic conditions and

microbial distribution at different horizons.

2 Objects and methods

Short description of the studied region. In steppe Priol'khonie region salt lakes meet. They are small with elongated or round shape. Two lakes of thermokarst origin are located in Tagotskij hydrolaccolith area at an altitude of 552 m above sea level. The first small lake has a square of 15 000 m², another one – of 42 024 m². Lakes have slight difference in salinity and physico-chemical composition of waters, due to varying degrees of metamorphism feeding precipitation and groundwater. Hydrolaccolith is outlier with rounded shape and varying heights, within which ice lens lie horizontally. Regosol is a rough mineral soil formed on the parent rocks of different degree of weathering, with poorly differentiated incompletely profile and bland humus horizon.

Sample collection. Soil samples were taken in May 2011, from the soil surface to a depth of 110 cm every 10 cm. Samples were stored at -20° C until further experiments.

Physico-chemical analysis. Analysis of physicochemical properties was carried out in the laboratory of Soil Science at the University of Martin Luther - Halle (Germany) and in the laboratory of Irkutsk State University (Vorobieva, 2006). Acidity was determined by the potentiometer at a ratio of soil to water - 1:2.5; with 0.01M CaCl₂ - 1:2.5; conductivity - 1:10. Carbonates were analyzed by gasometric method on C-MAT 550RS with decomposition of carbonate with 40% H₃PO₄. C and N were detected by combustion at VarioMax CNS-Analysators (CN-Betrieb); NH₄⁺ and NO₃ were isolated with 1M KCl and definition on SANSplus. Content of N, P, and K was analyzed by ICP-AES with pre-extraction CaC₆H₁₀O₆•5H₂O (Doppel-Lactat-DL) with the

* Corresponding author. E-mail: nlbelkova@gmail.com

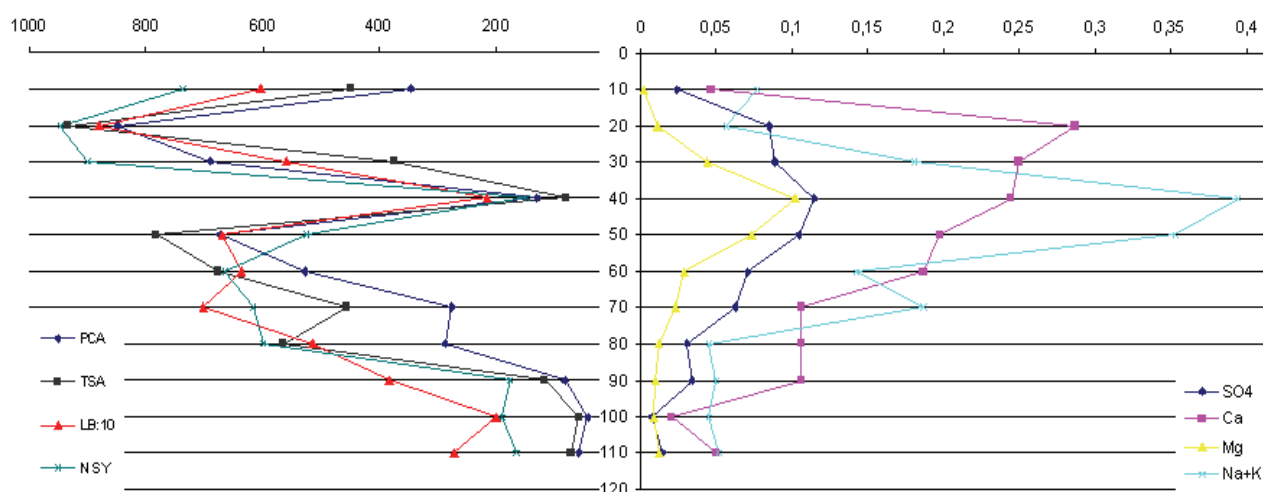


Fig. 1 Distribution of salt and heterotrophic microorganisms along the profile hydrolaccolith.

addition of 0.01M HCl.

Heterotrophic microorganism cultivation.

Enumeration of heterotrophic microorganisms was performed using media with different qualitative and quantitative composition of organic and mineral components: NSY (g per 1 L: nutrient broth - 1.0, soy peptone - 1.0, yeast extract - 1.0, agar - 15.0, LB:10 (g per 1 L: trypton - 1.0, yeast extract - 0.5, agar - 15.0), TSA (40 g commercial media per 1 L), PCA (23.5 g commercial media per 1 L). Cultivation was done at 20°C. Counting of colony forming units (CFU) was conducted on 3 and 7 days of incubation. Single colonies were used for pure culture isolation. Cells and colonies were described using a light microscope (Micmed P-13-2, Russia) at 100× magnification.

3 Results and discussion

Regosol of Priolhonie region has mild signs of pedogenesis. Its properties are determined by the carbonate content of parent rock and the presence of deluvial deposits at the depths of 10-30 cm. In the middle of the profile from the depth of 60 cm there is clearly distinguished buried organic horizons containing vegetative residues (peat), indicating the hydromorphic stage. Pedogenesis has low intensity because of permafrost limitation.

Soil has been characterized with high carbonate content by chemical analysis. Carbonates are mostly mealy and impregnated full profile. CaCO_3 content varied in the soil from 14.52 to 68.17% with maximum in the middle of the profile in the frozen horizon at a depth of 40-70 cm (Fig. 1). Treatment of the samples with 40% H_3PO_4 results in the overestimated data due to the abundance of shells. Probably in the middle and lower part of the profile the carbonate

precipitation has been done in the cold period of soil evolution. Currently, a maximum of soluble salts have been detected at the same level.

In the lowest layer the presence of non-rounded silt and debris indicates the accumulation of the material by diluvial drift from the adjacent areas. Electrical conductivity characterized the total salt content has maximum values in the upper and middle parts of the profile up to frozen horizon (to 2.01 mS/cm). pH values of the aqueous suspension was near neutral (7.7) and slightly alkaline (8.4). It is evenly distributed along the profile with increasing down due to the presence of calcium carbonate. Horizon with CaCO_3 prevents the substance migration inside the profile, especially in its lower part. Values of lake water pH (8.8) have been correlated with soil pH.

According to data received organic matter formation have been held in a hydromorphic regime when a lake was in the place of hydrolaccolith, evolving into a swamp, as evidenced by the buried peat and sapropel horizon. Organic matter content is high and decreases along the profile from top to bottom (8.33-1.77%) to the parent rock (Fig. 1). Nitrogen content is no more than 0.73% at the top and 0.11% at the bottom of profile. The ratio of carbon to nitrogen have been varied with the depth from 18.8 to 30.6, revealed that soil slightly enriched with nitrogen. High content of total carbon is associated with inorganic ones. The fraction of inorganic carbon varied from 1 to 8%, which is probably due to carbonate deposition and the presence of sapropel.

Phosphorus content was estimated within hundredths of a percent, or it was not detected. Potassium and sodium have been included into soil salts, presented in the parent material and entered from groundwater. Variation in their content has been corresponded to the salt profile

distribution: from 0.8 mg/L in the upper part to 3.92 mg/L in the bottom.

Content of NO_3 and NH_4 have been increased at a depth of 30-40 cm. On this horizon morphologically expressed lake sapropel deposits which are rich in organic matter so-called "underwater form humus" could be observed. Nitrate and ammonium forms of nitrogen are an indicator of organic compounds availability in the soils. Nitrates are concentrated in the middle part of the profile (up to 796 mg/100 g), where buried organic horizons lies, and sharply decreased to the bottom (23 mg/100 g), due to the lack of organic matter in carbonate layer. Ammonia is present in the soil as the water-soluble salts and its content is uniformly along the profile (13-25 mg/100 g), with the exception at the upper horizon.

Enumeration of the total number of heterotrophic microorganisms revealed the maximum values on TSA medium both on the third (886.5 CFU/ml), and the seventh (934 CFU/ml) day of incubation (Fig.). the lowest number of CFU have been obtained on medium PCA. There are two maximum in distribution of heterotrophic microorganisms along the profile of hydrolaccolith at depths of 20 and 60-

80 sm. It should be noted that this finding has a positive correlation with the distribution of total and inorganic carbon (Fig.). Organic carbon is the main nutrient substrate for microorganisms. Decreasing of the total number of microorganisms at a depth of 40 cm (Fig.) is obviously connected with the presence of high content of salts at this depth which seems to inhibit the growth of heterotrophs (Fig.).

Key words: regosol, Priolkhonie, soil, microbial community, heterotrophic microorganisms, cultivation.

References

- Mats V.D. [et al.], 2001. Cenozoic of Baikal rift basin: the structure and geological history. Novosibirsk: SD RAS Publisher, 252.
- Popova S.M., Mats V.D., Chernyaeva G.P. et al. 1989. Paleoclimatic reconstruction (Baikal rift zone) – Novosibirsk: Nauka. SD RAS, 111.
- Vorobieva G.A. 2006. Theory and practice of chemical analysis of soil. – M.: GEOS, 400.
- Vorobieva G.A. 2011. Tagotskij hydrolaccolith. Soil as a link in the functioning of natural and anthropogenically transformed ecosystems. Irkutsk. 38.