COMPARISON OF MICROBIAL COMMUNITIES OF THE RHIZOSPHERE OF HALOPHYTES AND BACKGROUND SOILS OF THE ARAL REGION

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Abstract. *The article presents data obtained from the study of soil and rhizosphere microorganisms taken from natural sources in the Aral Sea regions. A diversity of physiological groups of microorganisms was discovered, primarily halotolerant bacteria and fungi, in soil samples taken from the Aral Sea region and the shores of the Aral Sea in the autumn period of the year. Soil taken from the rhizosphere of xerophytic plants "Rhubarb" (Rheum), "Nitrária" and "Saxaul" (Halóxylon) turned out to be rich in mycobiota. The identified cultures of various physiological groups of microorganisms in the soil of the Aral Sea region and the rhizosphere of xerophytic plants are of interest for assessing the biological potential of arid territories and creating biological products that are stable to stress conditions for the development of arid, saline lands of the Republic.*

Keywords*: Aral Sea, halophytes, rhizosphere, physiological groups, identification, microorganisms, abundance, significance.*

Introduction

At present time a particular attention has been given to rhizosphere microorganisms and their importance in the life of plants. The rhizosphere is the main localization center or site for the formation and development of microbial communities belonging to various taxonomic groups.

In symbiosis with plants, the main groups of microorganisms establish a close relationship, especially associative rhizobacteria with the partner plant, which participate mainly in the processes of nitrogen fixation [1]. They, through the release of phytohormones, improve phosphorus and nitrogen nutrition, thereby ensuring stress resistance of plants, especially on saline soils. Also, they provide indirect stimulation of the antagonistic activity of rhizosphere microorganisms against phytopathogens, to protect them in extreme environmental conditions [2].

As for the place of study, it should be noted that the Aral Sea region is an integral part of the Turgai-Turan plateau with a territory (135 thousand km2), which is characterized by arid lands, low-mountain plains, and saline depressions. The southern, central and eastern Aral Sea region are represented by the deltas of the Amu Darya and Syr Darya. The area is occupied by sandy deserts and saline soils [3]. The Aral Sea regions are distinguished by a sharply continental climate, strong insolation, hot climate, with increased dry air, low amounts of precipitation even in the winter and autumn periods of the year. The region is characterized by high aridity, which is increasingly spreading due to the drying of the Aral Sea. The climatic conditions of the Aral Sea region are becoming harsh for the reproduction of plants and steppe animals, which is due to changes in unfavorable biological processes in Central Asia due to global warming and lack of water resources, and most importantly, a sharp and prolonged drop in the water level of the Aral Sea [4].

All these processes cause concern not only among scientists in our country, but also throughout the world, which dictates the conduct of real research to preserve xerophytic plants, the biodiversity of soil microorganisms and other biological creatures that survive and exist in these conditions [5,6].

Therefore, the purpose of this work was to identify and quantify the main groups of soil microorganisms inhabiting the rhizosphere of halophytes and background soils of the Aral Sea region.

Materials and methods for studying soil microorganisms

Soil samples in various soil sections were taken from the rhizosphere of halophytic plants (Fig. 1) from the shores of the Aral Sea and the Aral Sea region in the autumn peri od of the year. The air temperature during sampling was 0°C+4°C during the day and 0°C.-3°C at night, soil moisture was 14-15%. Some soil samples were taken from the rhizosphere of the following desert xerophyte plants:

1. Rhubarb (Rhéum officinále) is a perennial herbaceous plant with a highly developed root system, up to 2 m high, with a fragile, juicy straight stem, finely grooved, hollow, with small fibers, and sour in taste.

2. Halophytic plant saltpeter (Nitrária), low thorny and branched shrubs 0.5-2 m high with alternate, entire or slightly serrated fleshy leaves, with small stipules

3. Saxaul (Halóxylon) is a valuable desert tree that stabilizes sandy soils, the wood is very hard, the roots are deep.



1 - Rheum ***2- Nitrária*** ***3- Halóxylon***

Fig.1. Halophytic plants of the Aral Sea region are the main objects for the study of rhizosphere microorganisms

Methods for studying soil microorganisms

For separating microorganisms and determine the microbial landscape, nutrient media were used, described in the manuals of Egorov A.E. and Netrusov. A.I. [7]. Ready-made nutrient media were used in the work: MPA medium for determining the total number of saprotrophic microorganisms, MPB for ammonifying bacteria, Endo and EE Broth for determining the total number of the Enterobacteriaceae family and produced by Hi Media. To study fungi, the following media were used: Czapek-Doxa (for isolating microscopic fungi) (g/l): $NaNO_3$ – 2; KH_2PO_4 - 1; KCl – 0.5; $MgSO_4$ * 7 H_2O - 0.5; $FeSO_4$ * 7 H_2O – 0.01; Sucrose – 30; If – 20, the rest distilled water – 1000 ml. The medium was sterilized at 0.5 atm for 20-30 minutes. Hutchinson's medium was used to study aerobic cellulose-decomposing microorganisms) (g/l): KH_2PO_4 – 1.0; $CaCl_2$ * $6H_2O$ – 0.1; $MgSO_4$ * H_2O - 0.3; $FeCl_3$ * 6H2O – 0.01; $NaNO_3$ – 2.5, the rest distilled water – 1000 ml Omelyansky's medium was used to study ammonifiers of the following composition (g/l): $(NH_4)2$ HPO_4 - 1.0; KH_2PO_4 - 1.0; MgSO4 * 7H2O - 0.5; CaCO3 – 2.0; NaCl – traces, the rest distilled water - 1 l, Postgate medium “C” was used to determine phosphorus-mobilizing

microorganisms, (g/l): Dep. KH_2PO_4- 0.5; Na_2SO_4 - 1.0; $CaCl_2 * 6H_2O$ - 0,06; $MgSO_4 * 7H_2O$ - 0,06. Separate Na lactate - 6.0. Separate yeast extract -1.0; Na citrate – 0.3, the rest distilled water – 1 l., Ashby's medium (g/l): mannitol – 20.0; KH_2PO_4- 0.2; MgS04 - 02; NaCl - 0.2; K_2SO_4 - 0.1; $CaCO_3$ - 5.0; agar - 20.0; pH 7.1–7.3 was used to identify nitrogen-fixing microorganisms.

The pH value of the nutrient medium was adjusted to pH=7.2-7.3 using 0.01 n KOH by determination on a Mettler Toledo pH meter.

Determination of microorganisms present in 1.0 g (1 ml) of soil suspension was carried out by the method of serial dilutions with seeding on solid and liquid selective media. The number of microorganisms in liquid media was determined using the McCready table [8], and the number of CFU on solid media was calculated using formula, at a confidence level of 95% (P 0.95):

$$(x \pm 2 \sigma x-)\bullet K\bullet 1/V,$$

Where $x= \Sigma x / n$ is the average number of colonies grown when seeded from a given dilution; $\sigma x- = \pm\sqrt{} \Sigma x / n$ - standard deviation; 2 - t – criterion at P 0.95; K - dilution from which seeding was carried out; V is the volume of suspension taken for inoculation, ml; Σx is the total number of colonies counted when sowing a given dilution; n is the number of repetitions.

To isolate soil microorganisms, selective media were used, respectively, for each type of microorganism. To suppress foreign bacterial infection, 200 μg/ml ceftriaxone and NaCl solution at concentrations of 5%–15% were added to the medium according to the method [8].

Results and its discussion

Soil microorganisms - their presence, numbers and properties are of great importance in preserving the biodiversity of vegetation in desert zones, on which the biological cycle of all living organisms depends.

Soil microorganisms, especially those inhabiting the rhizosphere of desert plants, make a huge contribution to the carbon cycle in the biosphere cycle and to the utilization of various salts, which are present in the soil in excess concentrations, sometimes exceeding 30%/100 grams of soil. These microorganisms, thanks to their biosynthetic properties to assimilate nitrogen, secrete phytohormones and other biologically, physiologically active substances in symbiosis, help plants survive in such super critical conditions of anhydrous conditions, high temperatures and sandy soils.

Experiments to identify m caviar organisms belonging to different taxonomic groups in 6 soil samples taken from the Aral Sea regions showed different results depending on the location and type of desert plants (Table).

*Soil samples	Ammonifiers	Micromycetes	Phosphom obilizing	Cellulose decomposing	Nitrogen-fixing
№-1	$1,2x10^6$	were not observed	$1,1x10^4$	$1,1x10^3$	$2,0x10^6$
№-2	$2,5x10^5$	were not observed	$3,0x10^4$	were not observed	$1,1x10^3$
№-3	$4,0x10^5$	were not observed	$1,6x10^4$	were not observed	$1,3x10^4$
№-4	$7,1x10^5$	$3,2x10^2$	$2,8x10^5$	$2,3x10^3$	$5,0x10^4$
№-5	$6,1x10^5$	$1,9x10^6$	$2,5x10^3$	$2,9x10^3$	$7,0x10^3$
№- 6	$5,2x10^5$	$1,7x10^5$	$2,8x10^3$	$1,2x10^3$	$8,1x\ 10^4$

*Note: soil samples: N. 1 - from the shore of the dried bottom of the Aral Sea (15x20 cm), N. 2 - from the shore of the dried bottom of the Aral Sea under the rhizosphere of the halophytic plant Nitraria (15-20 cm from the surface), N. 3 - Southern Ustyurt, 10 cm from the soil surface, N. 4 - saxaul rhizosphere, N. 5 - Rheum rhizosphere, N. 6 - saltpeter rhizosphere (Nitrária).

As a result of the experiments, it was found that 6 soil samples contained ammonifiers, microscopic fungi, phosphorus-mobilizing and nitrogen-fixing bacteria, as well as cellulose-decomposing microorganisms, which differed in number and location.

Soils taken from the saxaul rhizosphere turned out to be rich in microflora, where ammonifying bacteria (7.1x105), then nitrogen-fixing bacteria (5.0x104), microscopic fungi in the amount of 3.2x102, were the largest in number, while phosphorus-fixing bacteria and cellulose-decomposing microorganisms were two orders of magnitude higher less than other microorganisms.

Despite the fact that soil sample N. 2 was taken from the rhizosphere of the xerophytic plant Nitraria growing near the shore of the dry bottom of the Aral Sea, microscopic fungi and cellulose-decomposing microorganisms were not found in the soil composition.

Soils from the rhizosphere of desert plants, such as saxaul, then the rhizosphere of rhubarb, then the rhizosphere of saltpeter, turned out to be rich in microflora. The predominant numbers among all physiologically different classes of microorganisms were ammonifiers (5.2x105), nitrogen-fixing bacteria (8.1x103) from the rhizosphere of saltpeter (Nitrária). An interesting fact was that the soil taken from the shore of the Aral Sea from a depth of 15x20 cm had a meager number of microorganisms, except for nitrogen-fixing bacteria, found in the amount of 2.0x106, which indicates a struggle for survival and vital activity in the soil depth of 20 cm, with soil moisture 15%.

Thus, as a result of the studies, the diversity of physiological groups of microorganisms, primarily halotolerant bacteria and fungi, was shown in soil samples taken from the territory of the Aral Sea region and the shores of the Aral Sea in the autumn period of the year from soil taken from the rhizosphere of xerophytic plants, such as “Rhubarb” "(Rheum), "Nitraria" and "Saxaul" (Halóxylon).

The identified cultures of various physiological groups of microorganisms in the soil of the Aral Sea region and the rhizosphere of xerophytic plants are of great interest not only from the point of view of the possibility of growth of halophytes and halotolerant plants in unfavorable environmental conditions, but also as objects for further research of their biological potential with the aim of using them in the fight against desertification and development of arid, saline lands of the Republic, constituting more than 80% of the territory, which are in dire need of bioremediation processes.

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