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METHODOLOGICAL ASPECTS OF ASSESSING THE STATE OF THE SOIL MICROBIAL COMPLEX IN AGROCENOSIS

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Abstract. This study justifies the selection of a set of diagnostic indicators for assessing the state of the soil microbial complex by combining the quantitative counts of microorganisms from key physiological and taxonomic groups with the calculation of an integral indicator of soil biogenicity and four ecological coefficients that reflect the direction of microbiological processes. The scale for assessing microbial abundance in soils has been standardized and expanded. Additionally, a new scale has been proposed to evaluate soil biogenicity and the intensity of microbial organic matter transformation.
Keywords: soil microbiome, physiological groups of microorganisms, soil biogenicity, ecological coefficients.

The state of the soil microbial community is an integral indicator of its biological activity, fertility, and ecological stability, since the microbiota plays a leading role in organic matter transformation, the cycling of biogenic elements, humus profile formation, and the maintenance of soil homeostasis. Given the diversity of microbiological parameters, it is essential to employ a comprehensive system of diagnostic indicators that combine both quantitative and functional-ecological characteristics of the microbiota. However, the high labor intensity of the full range of analyses requires the use of a representative minimum set of indicators with high analytical value, reproducibility, and informativeness.

Based on long-term research on soil samples collected from agrocenoses across various agro-climatic zones in Ukraine and Europe, conducted at LLC "INSTITUTE OF APPLIED BIOTECHNOLOGY", we have substantiated the selection of the following basic microbiological indicators of abundance for major taxonomic and physiological groups. These include micromycetes, actinomycetes, ammonifying, amylolytic, oligonitrophilous, oligotrophic, and pedotrophic microorganisms, as well as phosphate-mobilizing microorganisms

(mobilizing mineral /calcium, aluminum, iron/ and organic phosphorus compounds), cellulolytic, and humate-transforming microorganisms. We selected these groups as indicators because of their strategic role in biogeochemical cycles and the energetics of soil formation. Each of them serves as a specific functional link that determines the direction of matter and energy transformation.

Based on classical assessment scales (D.G. Zvyagintsev, V.I. Titova, A.V. Kozlov) and empirical microbiological soil studies (natural /virgin and anthropogenically altered), we propose a unified scale for evaluating soil biological richness. Unlike previous frameworks, it includes highly specialized functional groups: phosphate-mobilizing, cellulolytic, and humate-transforming microorganisms, as well as micromycetes and actinomycetes. Furthermore, phosphate-mobilizing bacteria that transform organic and mineral compounds are classified under the same gradation as oligonitrophilic and amylolytic bacteria. Actinomycetes should be assessed using a soil enrichment scale (million CFU/g of soil): very poor < 0.15; poor – 0.15–0.5; moderate – 0.5–1.5; rich – 1.5–2.5; very rich > 2.5. Micromycetes (thousands CFU/g of soil): very poor < 20; poor – 20–40; moderate – 40–80; rich – 80–160; very rich > 160. Cellulolytic (thousands CFU/g of soil): very poor < 20; poor – 20–40; moderate – 40–80; rich – 80–160; very rich > 160.

The soil biogenicity index (the total count of microorganisms across all studied groups) is included in the soil fertility assessment scale as an integral measure of its biological activity. Based on this indicator, the degree of soil enrichment is categorized as follows (million CFU/g of soil): very poor < 25; poor: 25–40; moderate: 40–80; rich: 80–180; and very rich > 180.

To integrally assess the direction of microbiological processes in agrocenoses, the evaluation focuses on calculating four ecological coefficients: mineralization–immobilization ($K_{M\text{-}I}$), microbial transformation of soil organic matter (K_{TOM}), oligotrophicity (K_O), and pedotrophicity (K_P).

Assessing K_{M-I} allows for determining the balance between the synthesis and degradation of organic matter, the availability of nutrients for plants, and the risk of dehumification at early stages –before changes in soil agrochemical properties become detectable. A K_{M-I} value > 1 indicates a predominance of nitrogen immobilization processes, where nitrogen accumulates in microbial biomass; this prevents leaching but may cause temporary competition for available nitrogen between microorganisms and plants. A K_{M-I} value < 1 indicates intensified mineralization, leading to the decomposition of organic matter and the accumulation of mineral nitrogen forms in the soil. A K_{M-I} value of 1 (±0.1) indicates equilibrium between organic matter synthesis and decomposition processes. The K_{TOM} of the soil reflects the intensity of microbial organic compound transformation. Its evaluation is carried out according to the following scale: very slow: K_{TOM} < 15; slow: K_{TOM} = 15–30; moderate: K_{TOM} = 30–80; intense: K_{TOM} = 80–140; and very intense: K_{TOM} > 140.

The K_O index allows us to determine the soil's supply of readily available nutrients essential for microbial functioning. An increase in the K_O value represents an adaptive response of the microbial community to deteriorating environmental conditions and serves as a diagnostic indicator of soil fatigue or the depletion of readily available organic matter. Specifically, a K_O value > 1 indicates a decline in readily available nutrients and the onset of adverse degradation processes, whereas a K_O value < 1 suggests that the soil microbiota is sufficiently supplied with these substrates. A K_O value of 1 reflects a balanced soil microbial community, characterized by an equal proportion of oligotrophic and saprotrophic microorganisms.

The K_P reflects the direction of metabolic activity within the microbial community, differentiating between the utilization of fresh organic matter and the breakdown and mineralization of the soil humus matrix. A K_P value < 1 indicates minimal involvement of

soil humus in transformation processes within agroecosystems, favoring organic matter conservation. Conversely, a K_P value > 1 indicates active development of the autochthonous soil microbiota and accelerated decomposition of mobile organic compounds (leading to a decrease in their content), as well as – depending on accompanying coefficients and agrochemical parameters – an intensification of either humification or dehumification. A K_P value of 1 reflects an equilibrium between the decomposition of fresh organic matter and the transformation of soil humus.

Thus, the selected set of indicators comprehensively reflects the architecture and functional potential of the soil microbial complex, determining the direction of microbiological processes. This ensures objective and detailed monitoring of the soil microbiocenosis while achieving an optimal balance among informational value, methodological relevance, and labor efficiency – which is particularly crucial for large-scale agroecosystem analysis.

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AGENT OF CROWN GALLS – *AGROBACTERIUM TUMEFACIENS* OF BLUEBERRIES (*VACCINIUM CORYMBOSUM* L.)

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Abstract. As a result of monitoring epiphytotia on the territory of the blueberry nursery, damage was detected in 60-80 % of planting material. Bacterial strains were isolated in pure cultures from the affected blueberry tissues and characterized for their complex of morphological-cultural and physiological-biochemical and pathogenic properties. It was established that the *Agrobacterium* spp. strains isolated by us are related to typical representatives of the genus *Agrobacterium*, in particular the species *A. tumefaciens*.
Keywords: blueberry, crown galls, *A. tumefaciens*.

Blueberry (*Vaccinium corymbosum* L.) is a low-calorie berry of the heather family, which contains many antioxidants, vitamins C and K, and also improves brain and heart function. It is believed that due to the high content of anthocyanins, it reduces the number of free radicals in the body and slows down the aging and tumor formation processes, which is why, in recent years, it has gained real popularity among consumers. According to the International Blueberry Organization (IBO), over the past 5 years, the world's volume of cultivated blueberries has doubled − to almost 2 million tons. The volume in the countries of South and North America did not increase significantly (about 20 %), while steady growth was observed in Asia, the countries of the European region and Africa (over 100 %). According to the literature, in 2026 Ukraine ranked 10th in the world and 1st in Eastern Europe in terms of blueberry area. The total area is about 6 thousand hectares (of which 5 thousand hectares are already bearing fruit). In 2025, the gross harvest was 14.33 thousand tons. However, the average yield of this berry still lags behind the world average and is only 2.87 t/ha, while the world average is 9.05 t/ha. One of the factors that prevents increasing the yield of this crop and achieving world values is damage by pathogens of various etiologies, including bacterial ones (Patyka V. P., 2017). According to world literature, blueberries can be affected by the following types of phytopathogenic bacteria: *Agrobacterium tumefaciens* − the