included in the API 20NE panel, as evidenced by the absence of or only occasional positive reactions to individual carbon substrates.

Taken together, the results obtained indicate substantial physiological and biochemical heterogeneity among the studied marine myxobacteria, manifested in variability in their temperature, pH, and salt tolerance, enzymatic profiles, and the spectrum of substrates they assimilate. The combination of physiological plasticity and the potential ability to hydrolyze complex organic compounds characterizes the studied strains as promising candidates for further investigation of their biotechnological potential.

References

1. Ahearne, A., Phillips, K.E., Knehans, T., Hoing, M., Dowd, S.E., & Stevens, D.C. (2023). Chromosomal organization of biosynthetic gene clusters, including those of nine novel species, suggests plasticity of myxobacterial specialized metabolism. *Front Microbiol.*, *14*, 1227206. https://doi.org/10.3389/fmicb.2023.1227206
2. Barzkar, N., Sukhikh, S., & Babich, O. (2024). Study of marine microorganism metabolites: new resources for bioactive natural products. *Front. Microbiol*. *14*, 1285902. https://doi.org/10.3389/fmicb.2023.1285902
3. Saggu, S.K., Nath, A., & Kumar, S. (2023). Myxobacteria: biology and bioactive secondary metabolites. *Research in Microbiology*, 174, 104079. https://doi.org/10.1016/j.resmic.2023. 104079
4. Zang, Y., Zhang, X., Wang, Z., Tong, Q., Zhou, Y., Yao, Q., & Zhu, H. (2024). *Hyalangium ruber* sp. nov, characterization of a novel myxobacterium strain s54d21 and their secondary metabolites. *Front Microbiol.*, *15*, 1369499. https://doi.org/10.3389/fmicb.2024.1369499

https://doi.org/10.30970/apmicro.2026.51

Kalinichenko O.[1], Kyseliova A.[1], Kolesnyk T.[1], Prekrasna-Kviatkovska Ye.[2], Iungin O.[1]

POLYHYDROXYALKANOATES IN SYNTHETIC MICROBIAL COMMUNITIES OF ANTARCTIC ENDOPHYTIC BACTERIA

[1]Kyiv National University of Technologies and Design,
2 Mala Shiyanovska St., Kyiv, 01011, Ukraine
[2]Ukrainian National Scientific Antarctic Centre,
16 Tarasa Shevchenka Blvd., Kyiv, 01601, Ukraine
e-mail: olgaungin@gmail.com

Abstract. This study investigates the accumulation dynamics of polyhydroxyalkanoates (PHA) in synthetic microbial communities formed by Antarctic endophytic bacteria isolated from *Deschampsia antarctica* and *Colobanthus quitensis*. We evaluated the influence of biofilm architecture (air-liquid-solid [ALS] vs. liquid-solid [LS]) and wide temperature range (4, 15, 25, 37, and 42 °C) on PHA biosynthesis. Quantitative gravimetric analysis and confocal laser scanning microscopy (CLSM) demonstrated that PHA accumulation is significantly enhanced in ALS multi-species biofilms compared to monocultures, peaking at 4 °C. Higher temperatures led to rapid depletion of energy reserves. Oxygen availability and spatial organization within the biofilm matrix are critical drivers of carbon allocation toward PHA storage in cold-adapted microbial communities.
Keywords: Polyhydroxyalkanoates, Antarctic endophytes, synthetic microbial communities, biofilm architecture, psychrotolerant bacteria, confocal microscopy.

The growing global contamination by synthetic plastics has accelerated the search for eco-friendly, biocompatible alternatives. Polyhydroxyalkanoates (PHA) produced by

microorganisms represent one of the most promising bio-based substitutes. However, the efficiency of microbial PHA biosynthesis heavily depends on environmental factors, including nutrient composition, temperature, pH, and trace element availability. Antarctic endophytic bacteria, adapted to extreme cold and low nutrient availability, possess unique physiological strategies for energy storage. Understanding how multi-species cooperation and biofilm architecture regulate PHA accumulation under temperature stress provides critical insights into cold-adaptation mechanisms and offers novel biotechnological avenues for low-temperature bioplastic production.

The objective of the study was to investigate the characteristics of polyhydroxyalkanoate accumulation in synthetic microbial communities formed by Antarctic endophytic bacteria and establish the effects of biofilm architecture and temperature regimes on PHA biosynthesis intensity.

Materials and Methods. Endophytic bacterial strains were previously isolated from vascular tissues of Antarctic plants (*Deschampsia antarctica* and *Colobanthus quitensis*) during the 24th Ukrainian Antarctic Expedition (2020) and identified via 16S rRNA gene sequencing. Synthetic microbial communities (SMCs) were assembled based on biofilm formation capacity of ALS (Air-Liquid-Solid) community included *Siminovitchia terrae* 9.1, *Pseudomonas salomonii* 10.1, *Pseudomonas yamanorum* 24.4, *Hafnia psychrotolerans* 25.2, *Pseudomonas* sp. 26.2, and *Pseudarthrobacter* sp. 26.7. And LS (Liquid-Solid) community included *Psychrobacter* arcticus 10.4, *Arthrobacter psychrochitiniphilus* 15.6, *Agreia* sp. 23.2, *Brachybacterium* sp. 39.12, and *Kocuria salsicia* 40.1. Standardized microbial suspensions (McFarland Standard 1, ~$3 \cdot 10^8$ CFU/cm³) were inoculated in minimal salts medium (MSM) and incubated under static conditions at 4, 15, 25, 37, and 42 °C for 3 and 6 days. Primary screening for intracellular PHA granules was performed using Sudan Black B staining under light microscopy (×1000). Total quantitative yield (% of cell dry weight) was determined gravimetrically following lyophilization and chloroform extraction. Biofilm architecture and spatial localization of PHA granules were visualized via Confocal Laser Scanning Microscopy (CLSM, Leica TCS SPE) using triple fluorescent staining: SYBR Green I (cellular DNA), Nile Red (lipophilic PHA granules), and Calcofluor White (exopolysaccharide matrix). Statistical significance was assessed using one-way ANOVA followed by post-hoc tests relative to the 4 °C reference group ($p < 0.05$).

Results and Discussion. Individual bacterial isolates in monocultures exhibited limited PHA biosynthetic capacity. In contrast, their assembly into complex ALS biofilms resulted in a substantial enhancement and stable deposition of PHA under low temperatures. Quantitative fluorescence normalization (Nile Red/SYBR Green I signal ratio) and CLSM imaging confirmed that intracellular PHA accumulation peaked at 4 °C. As incubation temperature increased (15–42 °C), a progressive inhibition of PHA synthesis and rapid reserve mobilization were observed. Long-term retention of polymeric reserves was characteristic exclusively of cold-cultivated biofilms. Oxygen availability and spatial stratification within the ALS biofilm structure proved to be critical determinants for carbon distribution between cellular growth and energy reserve storage. Integrating experimental data with comparative metagenomic analysis supports the hypothesis that aerobic metabolism provides the key ATP yield necessary for efficient PHA polymerization in extreme cold.

Conclusions. Synthetic microbial consortia of Antarctic endophytes display clear temperature- and architecture-dependent patterns of PHA biosynthesis. Cooperation within ALS biofilms significantly enhances PHA storage at 4 °C, reflecting a specialized cold-adaptation survival strategy. These findings deepen our understanding of polar microbial ecology and highlight cold-adapted synthetic consortia as promising platforms for sustainable, energy-efficient bioplastic production.

References

1. Auman, A. J., & Breezee, J. (2020). Polyhydroxyalkanoate production by psychrotolerant bacteria from polar environments. Applied Microbiology and Biotechnology, 104(12), 5211–5223.
2. Moshynets, E. V., & Karpenko, O. V. (2023). Biofilm matrix architecture and carbon allocation in extreme environments. Frontiers in Microbiology, 14, Article 1098234.
3. Subhash, G. V., & Rajvanshi, M. (2021). Microbial polyhydroxyalkanoates: Bio-based polymers for sustainable development. Bioresource Technology, 320, Article 124385.
4. Yungin, O. S., & Suslova, O. O. (2025). Endophytic microbial consortia of Antarctic vascular plants: Biofilm formation and metabolic potential. Ukrainian Antarctic Journal, 23(1), 45–58.

https://doi.org/10.30970/apmicro.2026.52

Karpinets L.[1], Lobachevska O.[1], Yavorska H.[2]

THE ROLE OF MOSS COVER IN THE MICROBIOLOGICAL TRANSFORMATION OF NITROGEN COMPOUNDS IN SOILS OF ANTHROPOGENICALLY ALTERED FOREST ECOSYSTEMS

[1]Institute of Ecology of the Carpathians of the National Academy of Sciences of Ukraine, 4 Kozelnytska St., Lviv, 79026, Ukraine
[2]Ivan Franko National University of Lviv, 4 Hrushevsky St., Lviv, 79005, Ukraine
e-mail: lyudmyla.vo@gmail.com

Abstract. In felling forest areas, the moss stimulates soil microbial metabolism and intensifies the conversion of N compounds in the soil, maintaining higher levels of mineral forms of the biogenic element throughout the growing season compared to bare substrate. By buffering the hydrothermal regime of the soil, accumulating dead shoot residue, and enhancing the infiltration of moisture enriched with labile nutrient compounds from the turf, moss promotes a spring increase in the activity of N compound transformation by microorganisms, with a summer peak in ammonification and an autumn maximum in nitrification.
Keywords: ammonifiers, nitrifiers, ammonium, nitrates, disturbed forest areas.

Bryophytes are a key functional component of many ecosystems. By modulating soil microconditions, they influence the dynamics of microbial biomass, as well as the abundance and structure of microbiocenoses (Siwach et al., 2024). Mosses stimulate ammonification and nitrification processes as basic stages of the N cycle, thereby determining ecosystem productivity (Glime, 2024). The removal of moss cover leads to soil nutrient depletion and a decline in microbial diversity (Cheng et al., 2021). At the same time, moss turfs contribute to the deposition of organic C and biogenic elements (in particular, N) in the surface substrate horizon (Karpinets et al., 2014; Wei et al., 2025) and to the accumulation of mineral N in the rhizoid layer of forest soils across varying gradients of anthropogenic pressure (Karpinets et al., 2025). Under the conditions of a transformed forest site – a felling area of beech-oak tree stands – it is relevant to study the impact of moss on the functional capacity of the ammonifying and nitrifying microbiota, which determines the intensity and specificity of N mineralization and the level of accumulation of its available forms (ammonium and nitrates) in the upper soil horizon. The aim of this study was to evaluate the characteristics of changes in NH_4^+ and NO_3^- contents, as well as the abundance of ammonifiers and nitrifiers in the soil beneath *Atrichum undulatum* (Hedw.) P. Beauv. under felling forest conditions.