DOI: 10.46991/JISEES.2025.SI1.077

Xylotrophic Fungi as A Biotic Factor in Biological Combustion of Woody Debris

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ABSTRACT

Forests are the most significant terrestrial ecosystems, regulators of the gas composition of the atmosphere and climate. Not surprisingly, their carbon cycle attracts the closest attention. Its unique feature is the presence of an aboveground wood pool of long-term carbon deposition, the volume of which in Russia is about 30 Gt. Mobilization of wood pool carbon occurs during the decomposition of woody debris, the reserves of which in Russia are 5.5 Gt. This process can rightfully be called biological combustion: as in the case of chemical combustion, oxidative conversion of organic carbon into CO_2 occurs with the release of water, heat, and mineral elements. With all the diversity of xylobionts, this process is mainly initiated by fungi (Basidiomycota, Agaricomycetes), which have the necessary adaptations for development in wood, the ability to solid-phase fermentation of the lignocellulose complex. The main characteristics of oxidative conversion of wood carbon are a) efficiency, assessed by the ratio of the volumes of emitted CO_2 and consumed O_2, and b) activity, assessed by the intensity of CO_2 emission. Xylotrophic fungi are effective mineralizers, the CO_2:O_2 ratio is usually 0.8 and higher and does not show a strict relationship with temperature and humidity. At the same time, the conversion activity in the range of 10-40 °C and relative humidity of 40-70% doubles with an increase in temperature by 10 °C and humidity by 10%. In other words, climate change is clearly associated with an increase in CO_2 emissions from the decomposition of woody debris. Moreover, since climatic factors, in particular temperature, affect both the intensity of fungal respiration and growth, this causes an exponential, directional-cumulative and irreversible increase in CO_2 emissions, which, in turn, can potentially accelerate climate change. Thus, xylotrophic fungi are biosphere-significant gas- and climate-regulating organisms, the importance of which has not yet been fully understood.

Keywords: fungi, basidiomycota, respiration, CO_2 emission, temperature, climate

Acknowledgement: This study was supported by Russian Science Foundation, projects No. 24-24-00404 and No. 22-24-00970.

References:

1. Kudeyarov, V.N.; Zavarzin, G.A.; Blagodatskiy, et al. Pools and fluxes of carbon in terrestrial ecosystems of Russia. **2007,** Moscow, Russia: Nauka, 315 p.
2. Mukhin, V.A.; and Diyarova, D.K. Eco-physiological adaptations of the xylotrophic basidiomycetes Fungi to CO_2 and O_2 mode in the woody habitat. *J. Fungi.* **2020,** *8,* 1296. DOI:10.3390/jof8121296
3. Mukhin, V.A.; Diyarova, D.K.; Gitarskiy, M.L.; Zamolodchikov, D.G. Carbon and Oxygen Gas Exchange in Woody Debris: The Process and Climate-Related Drivers. *Forests* **2021,** *12,* 1156–1171. DOI:10.3390/f12091156
4. Diyarova, D.K.; Vladykina, V.D.; Mukhin, V.A. Temperature effect on CO_2 emission by two xylotrophic fungi and by wood debris. *Russian J. Ecol.* **2023,** *54,* 213–220. DOI:10.1134/S1067413623030025
5. Mukhin, V.A.; Diyarova, D.K.; Zhuykova, E.V. The specific and total CO_2 emission activity of wood-decaying fungi and their response to increases in temperature. *J. Fungi* **2024,** *10,* 448. DOI:10.3390/jof10070448
6. Zavarzin, G.A. Carbon balance of Russia. Possibilities of preventing climate change and its negative consequences: the problem of the Kyoto Protocol: materials of the Council-seminar under the President of the Russian Academy of Sciences. **2006,** Moscow, Russia: Nauka, 134-151.

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