Abstract

The doctoral dissertation addresses the presence of cyanobacteria and microalgae in atmospheric aerosols in the coastal zone of the Gulf of Gdansk. After conducting a comprehensive review of the global literature on the current state of knowledge regarding airborne cyanobacteria and microalgae, the processes they undergo, and the aspects that require further scientific research, research objectives and tasks were determined, and hypotheses were formulated. They were verified during environmental studies and laboratory experiments. Based on them, utilizing specialized scientific research equipment, the quantity and taxonomic composition of cyanobacteria and microalgae in aerosols of various sizes were determined in both diurnal and seasonal cycles. Additionally, a qualitative and quantitative analysis of these microorganisms was conducted in rainwater during the peak productivity period of phytoplankton in the Gulf of Gdansk. Furthermore, it was demonstrated which meteorological factors determine the variability of cyanobacteria and microalgae occurrence in the air. An important aspect of the conducted research was to determine whether the cyanobacteria and microalgae present in the atmosphere of the Gulf of Gdansk coastal zone could pose a potential threat to human health. The objective of the study was to establish the presence of toxic organisms among them and to assess their ability to produce toxins, exemplified by microcystin-LR. The final objective of the research was to determine the influence of cyanobacteria and microalgae on the presence of benzo(a)pyrene in the air, which serves as an indicator of the level of contamination with polycyclic aromatic hydrocarbons.

The achievement of these objectives has allowed for a verification of the hypotheses:

H1. Cyanobacteria and microalgae are present in the atmosphere of the coastal zone of the Gulf of Gdansk throughout the year, probably due to increase in air temperature in recent decades.

H2. Among the meteorological factors determining the presence of cyanobacteria and microalgae in the atmosphere of the Gulf of Gdansk coastal zone, rainfall is the most significant.

H3. Cyanobacteria and microalgae suspended in the air can pose a potential threat to human health as a source of toxins and through the transfer of benzo(a)pyrene, which is an indicator of air pollution by polycyclic aromatic hydrocarbons.

In this study, it was determined that:

• The quantity of cyanobacteria and microalgae in the air of the coastal zone of the Gulf of Gdańsk varies from 0 to 1685 cells m^{-3}. In rainwater, their quantity ranges from 100 to 342×10^3 cells L^{-1}.

• These organisms are present in the atmosphere throughout the year. The highest quantity of microorganisms in the atmosphere is observed in July, which is a result of increased primary production in the Baltic Sea. The conditions favoring the occurrence of cyanobacteria and microalgae in the atmosphere are analogous to the conditions favoring phytoplankton blooms in the Baltic Sea during the summer period. This process is accompanied by an increase in air temperature and low wind speed.

• The most effective meteorological factor that leads to the removal of up to 87% of cyanobacteria and microalgae from the atmosphere is rainfall.

• In the Gulf of Gdansk region, cyanobacteria, green algae, and diatoms are dominant in the atmosphere. The research let to identify 29 taxa of cyanobacteria and microalgae, with cyanobacteria accounting for 60% of the total. With rainfall, these organisms are washed out of the atmosphere regardless of their taxonomic composition.

• Among the cyanobacteria and microalgae present in the atmosphere, there are taxa that are potentially hazardous to human health. They can be deposited in the deepest parts of the human respiratory system, such as the bronchioles of the lungs. However, most of these organisms (70%) are observed in larger particles (diameter > 7 μm), which are less harmful to health.

• The cyanobacteria present in the atmosphere can produce microcystin-LR, and its concentration varies for different strains, ranging from values below the detection limit to 420 fg $cell^{-1}$.

• Low concentration of B(a)P can lead to an increase in the number of cyanobacteria and microalgae cells in the atmosphere, as well as changes in the pigments content and the photosynthesis performance. Additionally, it has been established that the green algae present in the atmosphere are probably capable of degrading benzo(a)pyrene.