Cyanobacteria and microalgae in the coastal air: insights from a 5-year study in the Gulf of Gdańsk Region

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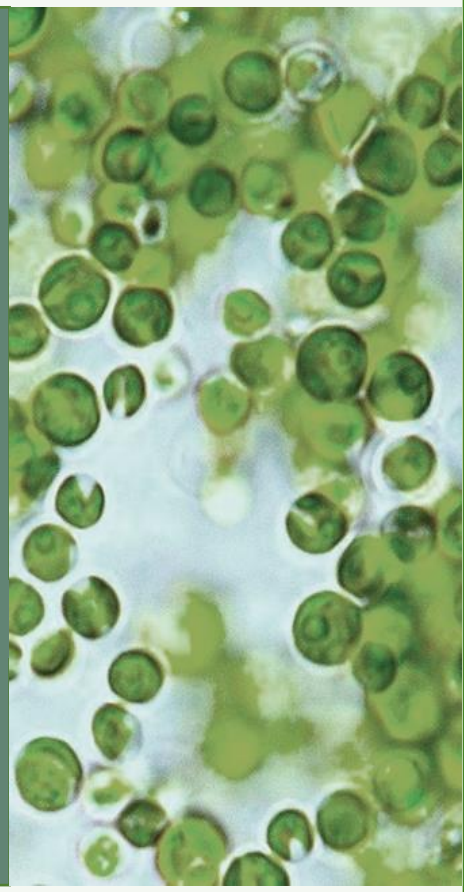

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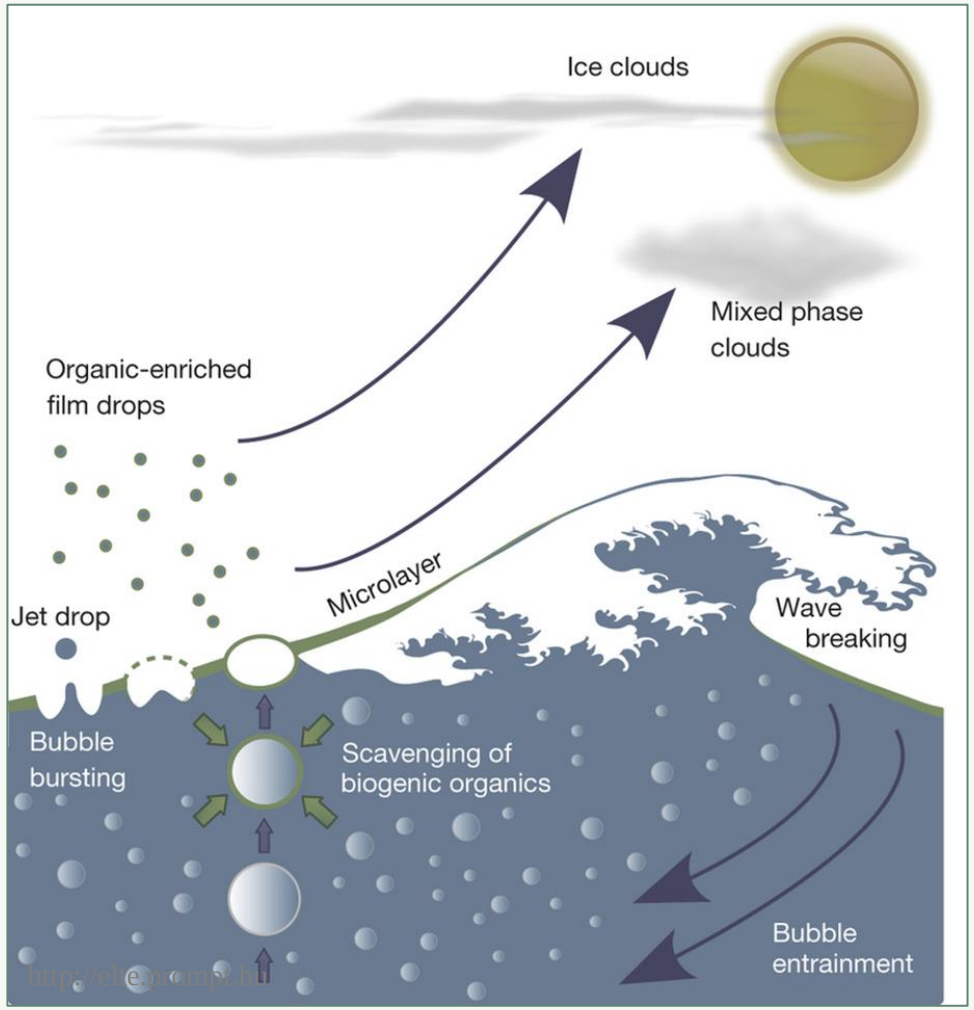
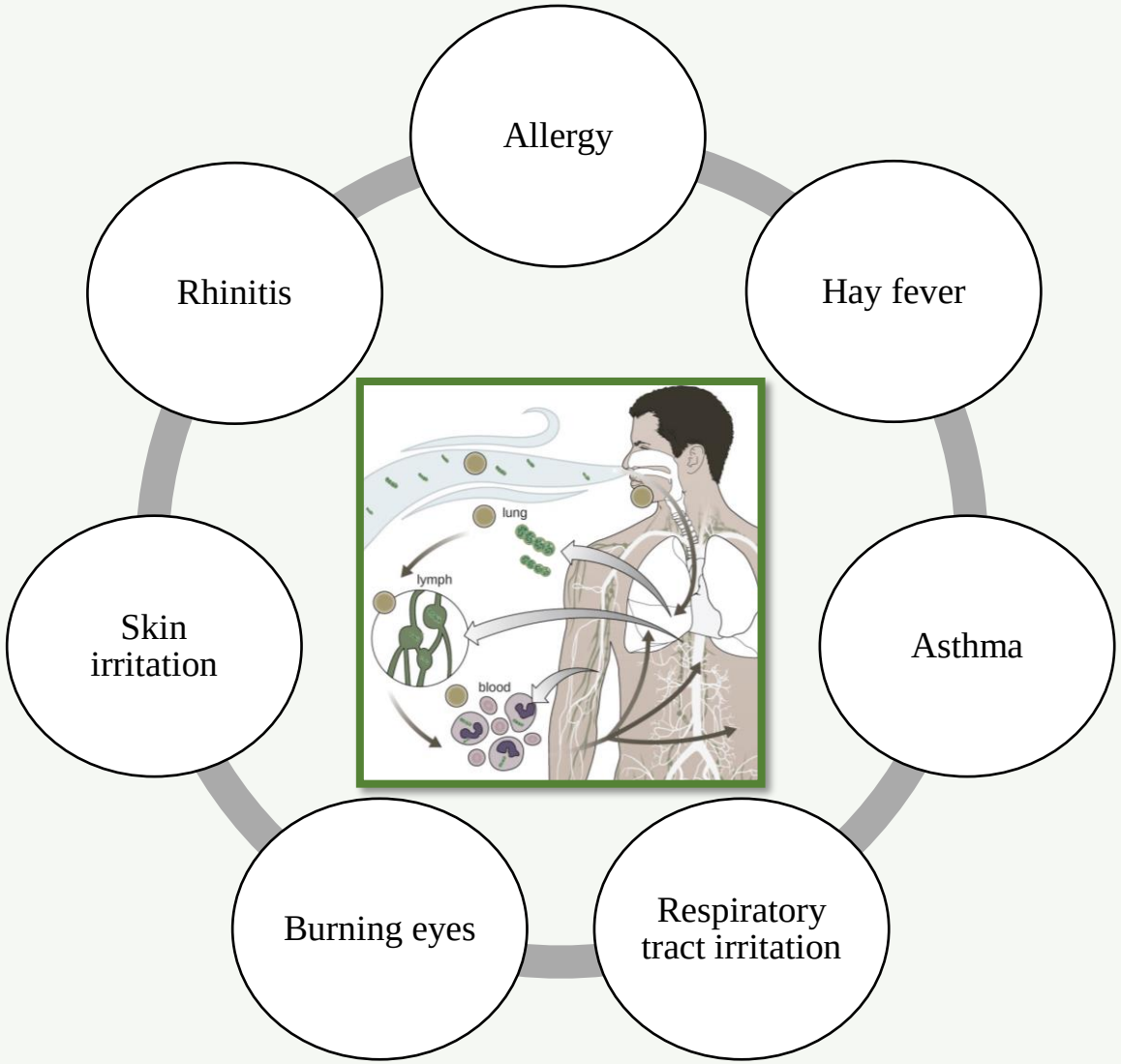
The origin of airborne cyanobacteria and microalgae



- Bursting of gas bubbles
- Wavelike motion of the wind
- Transported from soil, plants, and building surfaces (Sharma et al., 2006; Sorooshian et al., 2009

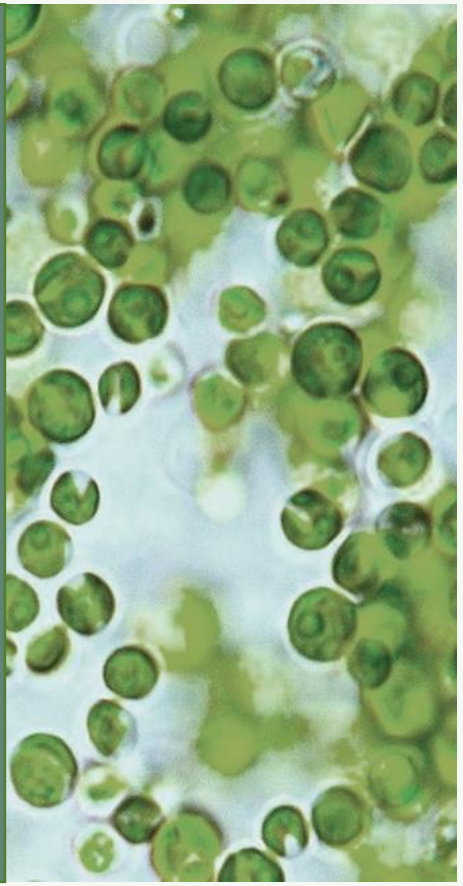
The impact on human health



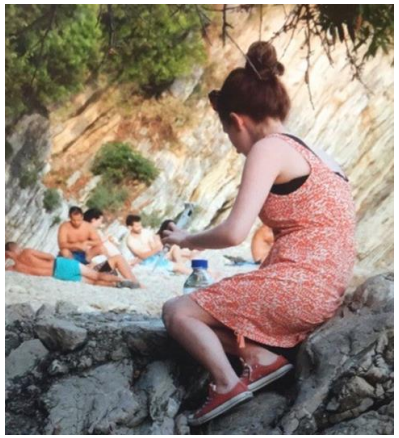
- Cyanobacteria and microalgae present in aerosols are inhaled by humans and then settle in the nostrils and lungs, posing a potential threat to human health (Genitsaris te al., 2011; May et al., 2018; Facciponte et al., 2018; Wiśniewska et al., 2019).

Reserach main goals

- The aim of this study was to determine the quantity and taxonomic composition of cyanobacteria and microalgae in the atmospheric air in the coastal zone of the Gulf of Gdansk
- To identify synoptic conditions/seasons that favor the presence of these microorganisms in the air
- To establish whether these organisms may pose a potential threat to human health.



Sampling

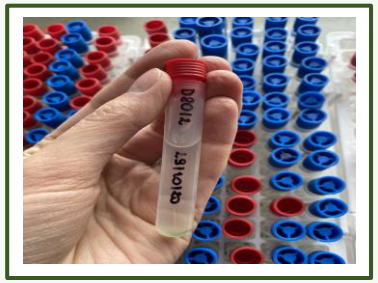


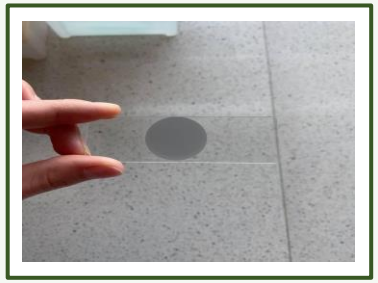
Facts

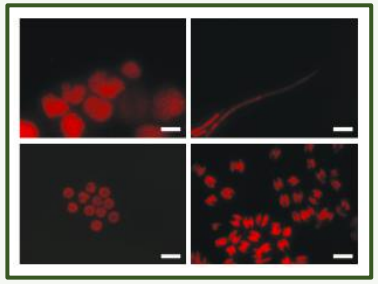
- 2015 – first sampling over the Gulf of Gdańsk
- 2020 – the largest measurement campaign
- Samples collected on the rooftop in the city center, on board a ship navigating the Gulf of Gdansk, and on the beaches along the coast of the Adriatic Sea.

Materials and methods

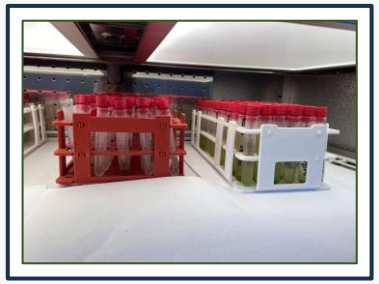
QUALITY AND QUANTITY

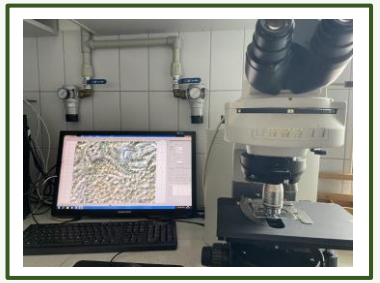


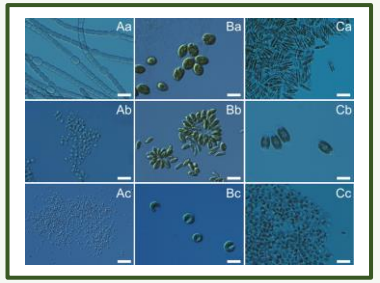




INCUBATION AND ISOLATION

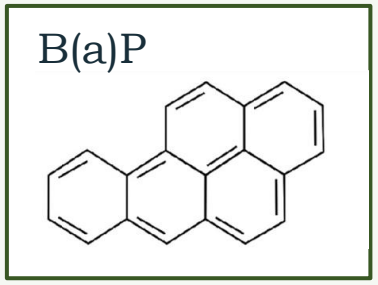




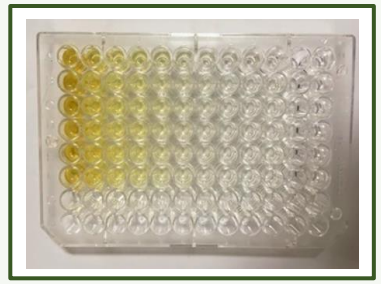


Materials and methods – addidtional experiments

IMPACT OF B(A)P ON CYANOBACTERIA AND MICROALGAE



IDENTIFICATION OF MICROCYSTIN-LR IN SAMPLES



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- Based on morphological characteristics, organisms were assigned to specific genera. Cyanobacteria and green algae constituted 63% and 33%, respectively, of all recorded organisms. The remaining groups accounted for approximately 4% of all recorded organisms.

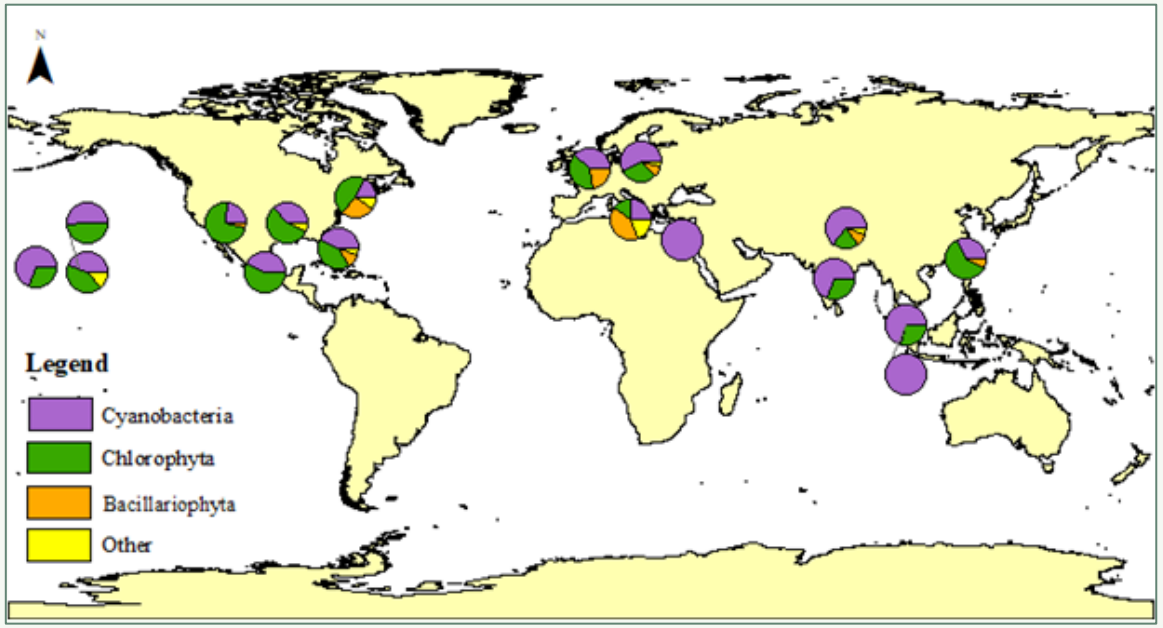


Fig. 2. Distribution of individual taxa in bioaerosols in different regions of the world. Personal analysis conducted using ArcMap 10.6.1 (Wiśniewska et al., 2019).

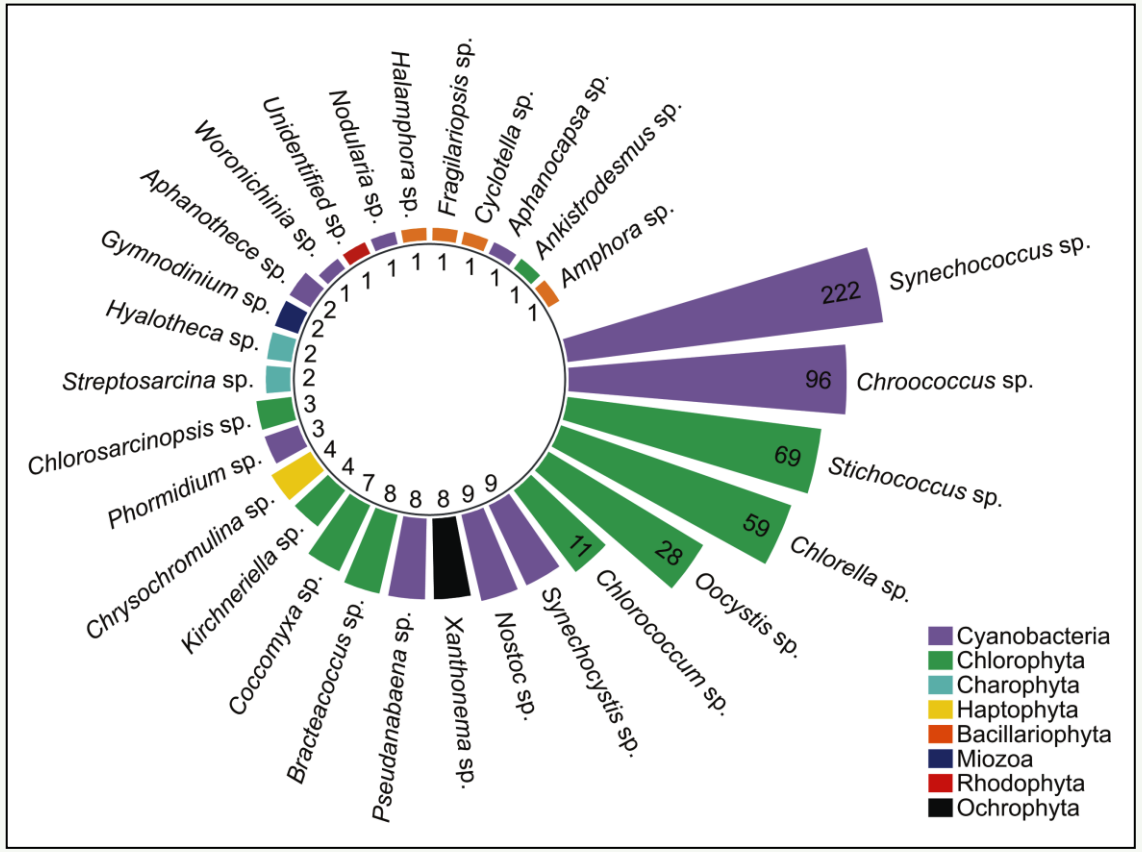


Fig. 1. Frequency of occurrence of cyanobacteria and microalgae in the air from January to December 2020 in the Gdańsk Bay region (Wiśniewska et al., 2022).

Seasonal quantitative and qualitative variability

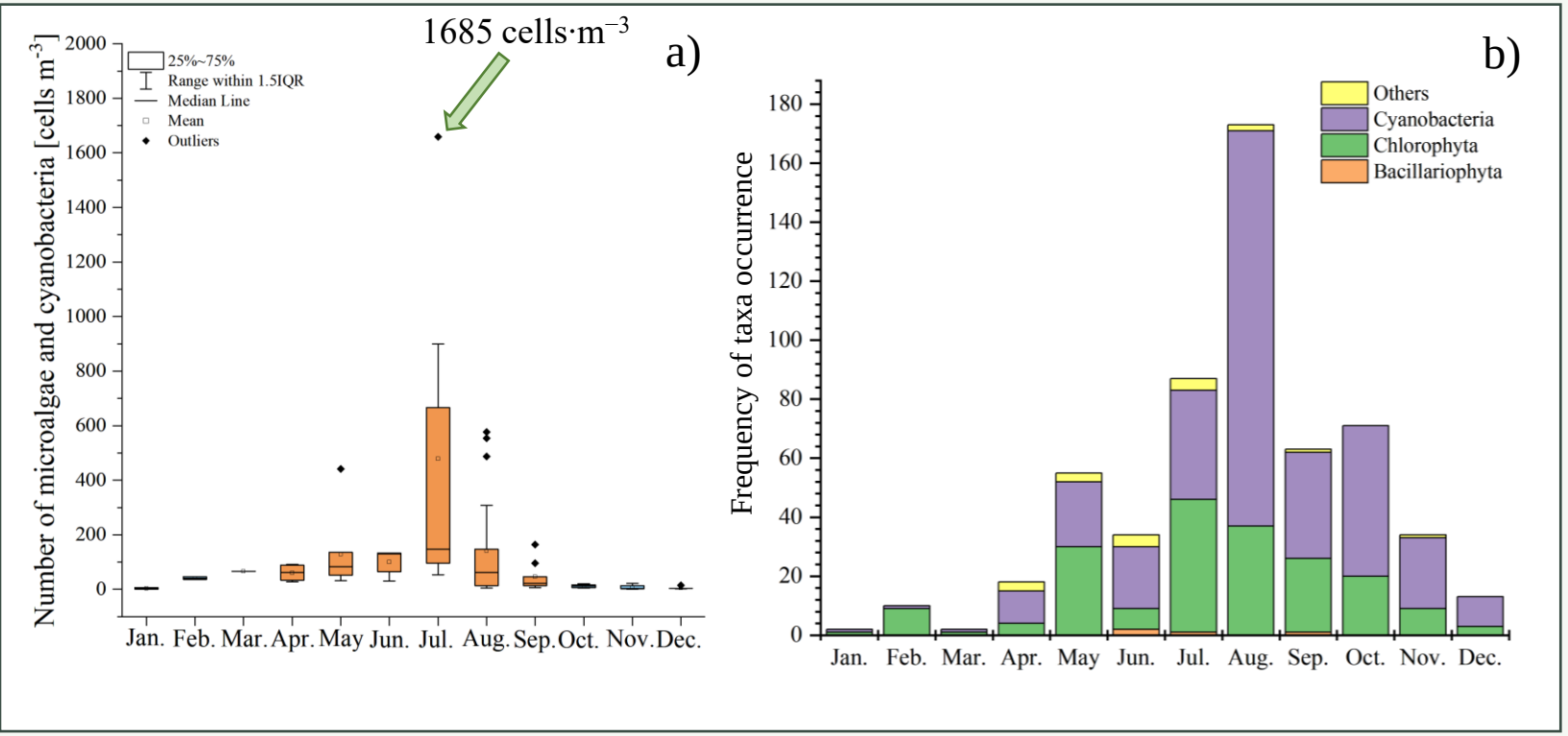
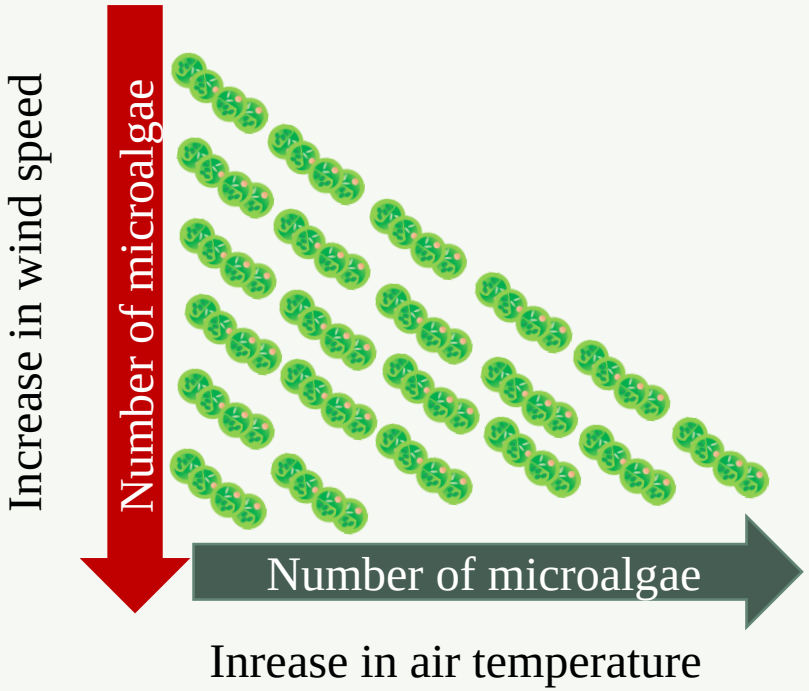


Fig. 5 Variability of a) quantitative and b) qualitative presence of cyanobacteria and microalgae in the air during each month of the year 2020 in the coastal zone of the Baltic Sea.

- The highest average number of cyanobacteria and microalgae cells was recorded in July (479 cells·m^{-3}).
- The greatest taxonomic diversity was observed in July, while the lowest was in January 2020.
- Exclusive presence of cyanobacteria and green algae was noted during the winter period.

Impact of meteorological



- The quantity of algae in the air decreased with an increase in wind speed (Spearman's rank correlation r = -0.83).
- With an increase in air temperature, the quantity of cyanobacteria and microalgae in the air increased proportionally (Spearman's rank correlation r = 0.76).

Impact of meteorological conditions

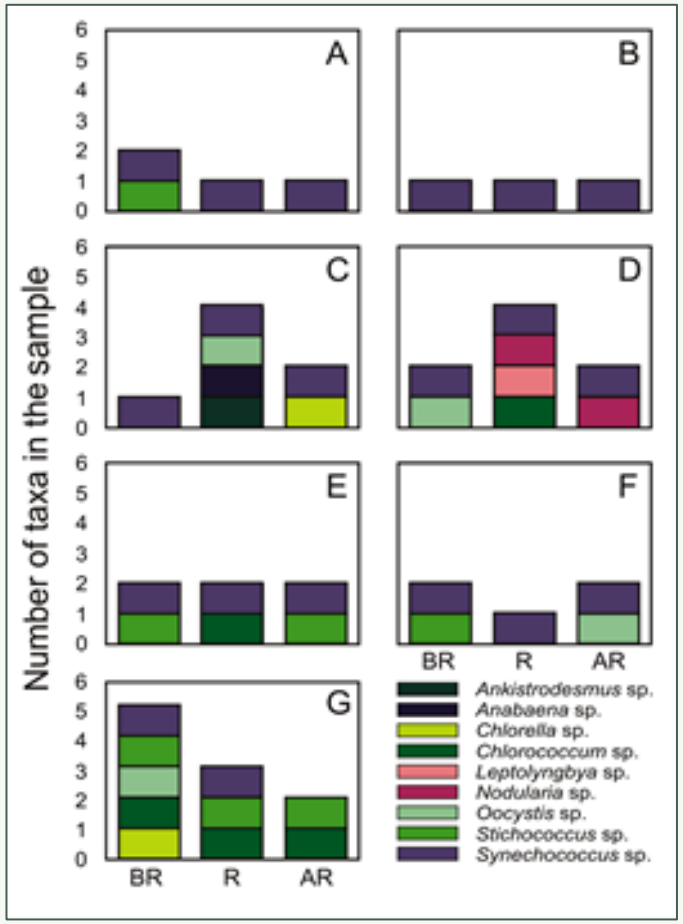


Fig. 8. Taxonomic composition of cyanobacteria and microalgae before rain (BR), during rain (R), and after rain (AR): morning 25.08.20 (A), afternoon 25.08.20 (B), 26.08.20 (C), noon 27.08.20 (D), evening 27.08.20 (E), 28.08.20 (F), from 30.08.20 to 01.09.20 (G)

- In the year 2020, rainfall recorded the presence of 400 to 5000 cells·L^{-1} of cyanobacteria and microalgae.
- After rainfall, there was a reduction in the quantity of cyanobacteria and microalgae in the air ranging from 21% to 87%.
- There is no evidence to suggest that the atmospheric cleansing process with rain significantly affects the taxonomic composition in the air.
- Rainfall may promote the reemission of previously deposited particles of cyanobacteria and microalgae into the air

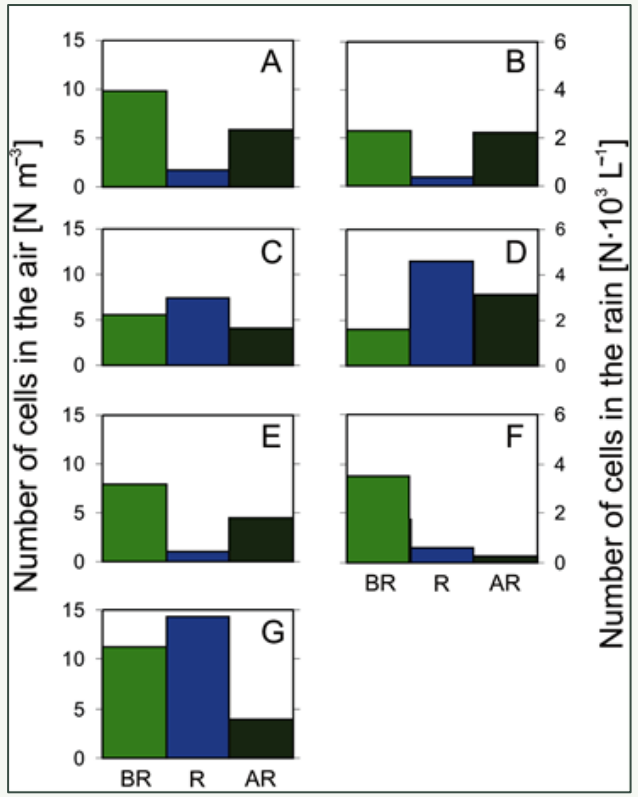


Fig. 6. Influence of rainfall on the taxonomic composition of cyanobacteria and microalgae in the air (Wiśniewska et al., 2022) *BR – before rain, R – during rain, AR – after rain

Quantitative depending on aerosol diameter

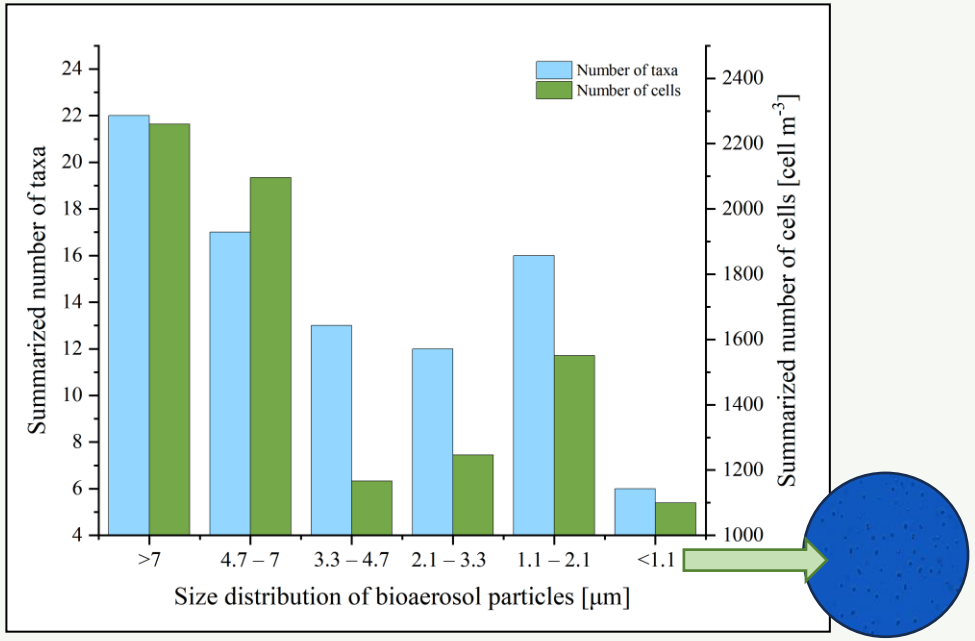


Fig. 9. Total number of cyanobacteria and microalgae cells in the air [cells·m^{-3}] and the number of taxa in different aerosol size ranges [µm].

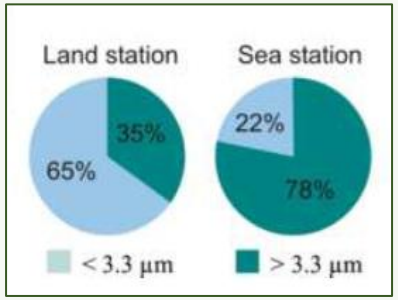
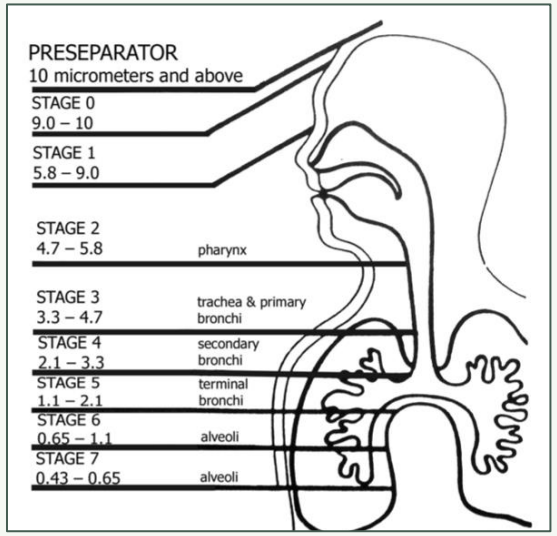


Fig. 10 The relationship between airborne cyanobacteria and microalgae size and sampling location [µm].

- The highest number of cyanobacteria and microalgae was recorded in the fraction with a diameter > 7 µm (2260 cells·m^{-3}).
- The lowest number of organisms occurred in the fraction with a diameter < 1.1 µm (1100 cells·m^{-3}).
- The location of the research station relative to the sea influences the size of the recorded fraction.



Main conclusions

- The highest amount of cyanobacteria and microalgae in aerosols was recorded in July. Their quantity increased with rising temperatures and a decrease in wind speed.
- It has been determined that the quantity of cyanobacteria and microalgae in the air reaches 1685 cells·m^{-3}, with cyanobacteria being the dominant group.
- Organisms potentially harmful to human health were present in the aerosols, even in the smallest fraction. Many organisms isolated from the atmosphere were capable of producing toxins such as Microcystin L-R.
- The efficiency of washing out cyanobacteria and microalgae with rain reached up to 87%. Rainfall may affect the taxonomic composition.

Identification of cyanobacteria and microalgae in aerosols of various sizes in the air over the Southern Baltic Sea

The first characterization of airborne cyanobacteria and microalgae in the Adriatic Sea region

Quantitative and qualitative variability of airborne cyanobacteria and microalgae and their toxins in the coastal zone of the Baltic Sea

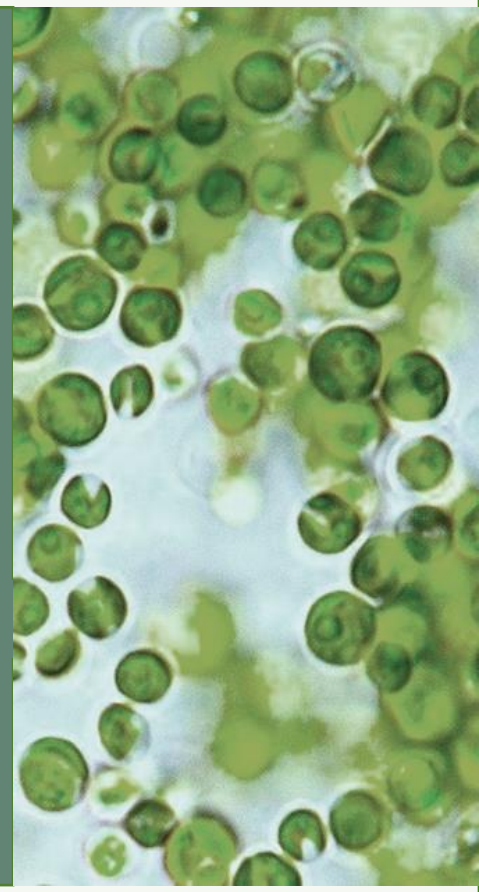
The effect of abiotic factors on abundance and photosynthetic performance of airborne cyanobacteria and microalgae isolated from the southern Baltic sea region

Airborne microalgal and cyanobacterial diversity and composition during rain events in the southern Baltic Sea region

The Ability of Airborne Microalgae and Cyanobacteria to Survive and Transfer the Carcinogenic Benzo(a)pyrene in Coastal Regions

The importance of cyanobacteria and microalgae present in aerosols to human health and the environment–Review study

Cyanobacteria and microalgae in the coastal air: insights from a 5-year study in the Gulf of Gdańsk Region



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