Assessment of the soil microbial status of urban parks in Plovdiv, Bulgaria

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OVERVIEW

Soil microbiology is a key component in urban ecosystems. Bacterial communities take part in different soil processes as mineralization of the organic matter, humus synthesis, nutrient supply and nitrogen fixation ((Beare et al., 1995). They are of primary importance for soil quality and natural productivity. Urban infrastructure and development are one of the most severe threats for microbial communities' structure and well-being (O`Donnell et al., 2001). Anthropogenic pressure results in pollution of all components of the urban environment, damaging the soil properties.

The purpose of this study is to assess the microbial status of soils from urban parks on the basis of total viable count of bacteria (TVC22 and TVC37), actinomycetes and fungi, combined with the presence of Escherichia coli (EC), fecal coliforms (FC) and fecal streptococci (FS) as a pollution indicator (Song et al., 2015).

Soil samples are taken from 8 urban parks in the city of Plovdiv with different degree of anthropogenic pressure - 4 big and 4 small, situated in the urban and suburban zone. All samples are dissolved into sterile saline and incubated at room temperature for 30 min on 200 rpm in order to free the microorganisms from soil particles. Standardized methods are used for studied parameters evaluation. Maximum of TVC22 and TVC37 were found in the big city parks in suburban zone. Fungi were also more abundant into soil samples from big parks and less presented into small parks in the west and central urban zone. Actinomycetes have not been found in two of the big parks which indicated their bad quality. Pathogenic forms were prevailing in the big parks, especially in the central urban zone. Statistical evaluation confirmed the relationship between the anthropogenic pressure and microbial status of urban soils, both with the influence of the wind rose as a factor.

INTRODUCTION

The soil is considered as a dynamic living system with an unique balance and interaction of its biological, chemical, and physical components. Microorganisms in soil ecosystems are ubiquitous, abundant, diverse and essential for many soil functions such as carbon and nitrogen cycling and plant productivity.

Because of their importance, we aimed to understand the ecology of soil microbial communities in urban parks and try to define the extent of anthropogenic pressure on them.

METHODS

Soil samples were taken in June 2017 from 8 stations, situated in four big (St. 1, 3, 5, 8) and four small (St. 2, 4, 6, 7) green parks in Plovdiv, Bulgaria (Fig. 1).

We used culturing techniques to compare the microbial population`s total viable count of bacteria (TVC at 22°C and 37°C), fungi and actinomycetes in soils (ISO 6222:1999; ISO 9308-1:2014; ISO 7899-2 2000; Pitt and Hocking, 2009). The presence of *Escherichia coli* (EC), fecal coliforms (FC) and fecal streptococci (FS) was used as a pollution indicator.

Fig. 1. Location of selected sampling stations

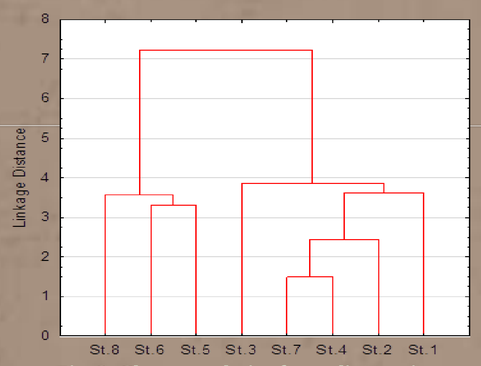

Fig. 2. Cluster analysis of sampling stations

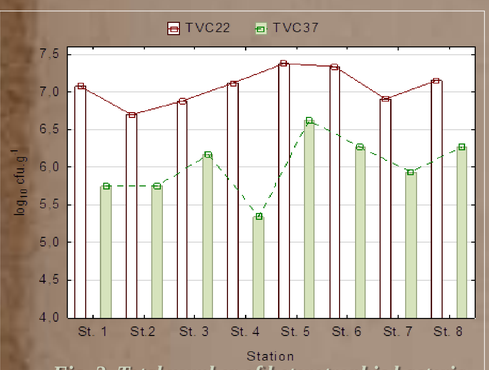

Fig. 3. Total number of heterotrophic bacteria (TVC22 and TVC37)

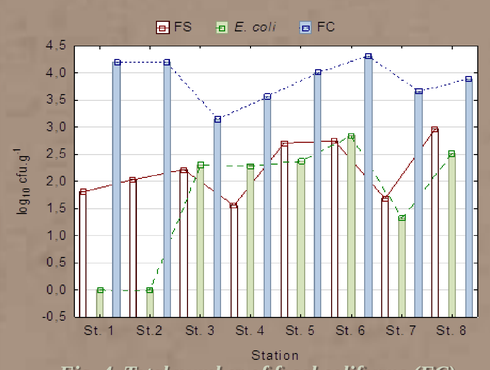

Fig. 4. Total number of fecal coliforms (FC), fecal streptococci (FS) and Escherichia coli

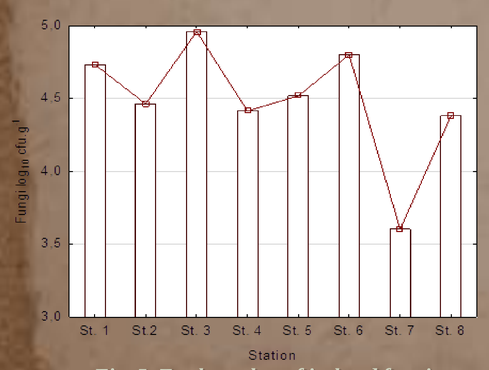

Fig. 5. Total number of isolated fungi

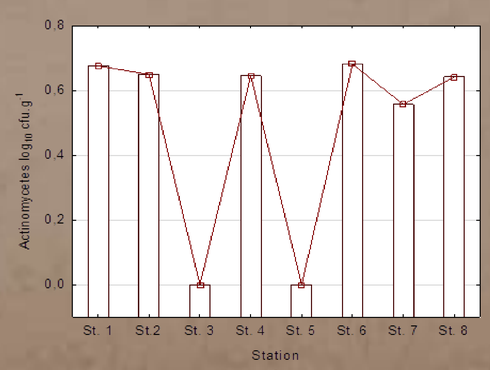

Fig. 6. Total number of isolated actinomycetes

RESULTS

The load of organic matter could be easily assessed by the total number of heterotrophic bacteria, cultivated at 22°C and 37°C (TVC22 and TVC37). Maximum were found at St. 5 and St. 6 (Fig. 3). St. 5 is located in the one of the biggest city parks which is characterized by the autochtonous and cultivated vegetation. This park is situated in the city periphery, at W direction (the wind rose in Plovdiv is W-E), and is subjected to low-to-medium anthropogenic pressure. St. 6 is located in a small park which is situated also in the city periphery, but at N direction.

E. coli was not found in samples from St. 1 and St. 2, both situated in the real city center, while both maximums of EC and FS were found in soils from St. 5, St. 6 and St. 8 (Fig. 4). FC were most abundant in soil samples from St. 1, St. 2, St. 6, followed by St. 5 and St. 8.

Fungi and actinomycetes play an important ecological role in soil formation and development. Lowest total count of fungi was found at St. 7 and the highest was found at St. 3 (Fig. 5).

Actinomycetes were missing at St. 3 and St. 5 (Fig. 6) which is an indication of poor soil quality.

We used tree clustering in order to evaluate similarity between the sampling stations (Mishra, 2010). Microbiological indicators had different magnitudes so prior to the analysis the raw data was standardized so that each variable has a mean of zero and a standard deviation of 1. Standardization was need to produce a normally distribution of all variables (Davis, 1973). Cluster analyses revealed that the selected sampling station could be divided in two main clusters with significant differences between them (Fig. 2). First one assumes very strongly related St. 5 and St. 6 , combined with St. 8. Second cluster includes the other five stations, where the highest similarity was found between St. 7 and St. 4, both located in small suburban parks. This sub cluster is related with St. 2 (small park in the central part) and St. 1 (big park in the central part). St. 3 (big suburban park) has the lowest similarity to the previous stations.

CONCLUSIONS

Soil-forming capacity of the studied areas is low and strongly influenced by the urbanization. Soils at St. 1, St. 2 and St. 6. have better quality according to the selected parameters. Statistical evaluation revealed that the main factors for soil status are the urban gradient, wind rose and anthropogenic activities, not the size and management of the park.

Finally, it can be added that the data provided are part of a project covering the whole territory of the city of Plovdiv and all the results obtained will show a more detailed picture of the anthropogenic impact in the urbanized area.

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