Urban chemistry as a new discipline exploring chemical and chemico-biological aspects of urban environment

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Abstract

Urban sciences can be divided into three directions: Natural, Humanities and Engineering. Within the fields of urban natural and urban engineering (technical) sciences, chemical and chemico-biological research take an important place. We propose using the new term "urban chemistry" (*i.e*. chemistry of the urban environment) focusing on the chemical aspects of the atmosphere, water bodies, and soil of cities. Urban chemistry is interconnected with urban ecology, toxicology and urban biology, and among the biological disciplines, it is particularly related to urban botany. Urban chemistry can be seen as a separate direction of urban natural sciences, which will significantly contribute to sustainable development of cities.

Keywords: chemistry of the urban environment; urban natural sciences; soil; urban air chemistry; plants; urban botany.

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LETTER TO THE EDITOR

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1. URBAN NATURAL SCIENCES

In urban sciences, great importance is given to humanitarian areas. We propose to distinguish three directions in the urban sciences: Humanities (social and humanistic sciences), Natural and Engineering (technical sciences). Within the latter two areas, chemical research is particularly important so that, one of the priority directions in urban natural sciences is chemistry of the urban environment.

2. URBAN CHEMISTRY (CHEMISTRY OF THE URBAN ENVIRONMENT)

Applied chemistry aims to solve practical problems by applying principles and theories of chemistry so that various branches exist including agricultural, food, environmental, pharmaceutical, medical, and industrial chemistry. We propose using the new term "urban chemistry" (chemistry of the urban environment) specifically focusing on chemical aspects of city areas. Topics on "Urban atmospheric chemistry" or "Urban Air Chemistry" have been in focus in recent literature [1,2], while it is also important to address chemical features of the other components of environment (i.e., water and soils). Thus, we propose to use the term "urban chemistry" for the entire urban environment, *i.e*. the study of the atmosphere, water bodies, and soil of cities.

Urban air chemistry is characterized by measurements of gas and aerosol compositions [1]. Conventional knowledge of global and regional atmospheric chemistry is not sufficient to predict the behaviour of pollutants in the urban atmosphere [2] since air pollution in cities has its own specifics. Many cities record high levels of air pollution, while the degree of urban environmental pollution can vary considerably within the cities. For example, high levels of air and soil pollution can be observed along highways in roadside areas. Vehicle emissions create corridors of increased carbon and nitrogen concentrations near highways that influence surrounding ecosystems [3]. Therefore, it is of great importance to assess the frequency of urban air pollution occurrence and its influencing factors[4].

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Particulate matter concentrations are usually higher in urban areas than in rural areas [5] and most urban dwellers in the European Union were reported to be exposed to particles and fine dust levels in excess of threshold values [6].

In addition, environmental monitoring of urban soil and water pollution is equally important. For example, deicing reagents and heavy metals were shown to pose a serious threat to urban soils and plants [7,8,9] and the main features of urban soil pollution are characterized by the accumulation of copper, zinc, lead and mercury[10]. Such contamination of urban soils with heavy metals, due to the rapid urbanization and development of urban services, has become a major environmental and human health challenge [11]. Similarly, water bodies in cities, such as lakes, may be more susceptible to pollution as compared to rural areas [12].

Major impacts of human activities on urban ecosystems are demonstrated by changed degrees of environmental pollution during the COVID-19 pandemic in some cities. For example, in Volos, Greece, significant changes in metal concentrations were observed in different parts of the city during the pandemic, due to the limited movement of motorized vehicles, but also due to the long operating hours of the heating systems in the residential area [13].

In order to solve environmental problems, interdisciplinary research within urban natural and urban engineering (technical) sciences is necessary such as the use of chemical technology as well as biochemical methods for urban waste treatment and water purification. Similarly, urban chemistry is interconnected with urban ecology, toxicology, and urban biology. Among the biological disciplines, urban chemistry is particularly related to urban botany (urban plant science) since urban pollution can influence plant biodiversity. High soil heavy metal and Na concentrations, along with the pH, were reported to induce intense negative effects on plant biodiversity [14].

The impact of chemicals on the environment of cities is often assessed in regard to the maximum permissible concentrations. However, these limits do not always take into account the effects of chemicals on plants as it is the case of maximal permissible concentrations of heavy metals [8]. The task for the future is to determine these concentrations in relation to certain plant species, which can be achieved with the help of biological and chemical sciences. Thus, the development of chemico-biological directions in urban sciences is important for the sustainable functioning of urban ecosystems.

We propose that urban chemistry is considered a separate academic discipline, which can be included in the curricula of Master's degree programs in "Ecology" and "Chemistry".

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Urbana hemija kao nova disciplina koja istražuje hemijske i hemijsko-biološke aspekte urbane životne sredine

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(Pismo uredniku)

Izvod

Urbane nauke se mogu podeliti na tri oblasti: prirodne, humanističke i inženjerske nauke. U okviru prirodnih i inženjerskih (tehničkih) urbanih nauka, posebno su značajna hemijska i hemijsko-biološka istraživanja. Predlažemo korišćenje novog termina „urbana hemija“ (hemija urbane sredine) sa fokusom na hemijske aspekte atmosfere, vodenih sredina i zemljišta gradova. Urbana hemija je međusobno povezana sa urbanom ekologijom, toksikologijom i urbanom biologijom, a među biološkim disciplinama, ova grana hemije je posebno povezana sa urbanom botanikom. Urbana hemija se može posmatrati kao poseban pravac urbanih prirodnih nauka koji će značajno doprineti održivom razvoju gradova.

Ključne reči: hemija urbane životne sredine; urbane prirodne nauke; tlo; hemija vazduha urbane sredine; biljke; urbana botanika