Bioindicators of Heavy Metals Pollution

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There is a wide interest in the air quality due to the constant development of many industries and technologies, as well as an extensive use of transport, ultimately leading to emissions of atmospheric pollutants. The application of ubiquitous organisms to assess air pollution has developed significantly during the last few decades. Such living organisms are successful indicators of the presence and availability of different contaminants over time. Lichens are a very popular and effective tool in bioimonitoring. They are usually applied by transplanting from unpolluted area to a contaminated one and assessing the bioaccumulation of the pollutants in the lichen tallus. On the other hand, spider webs are a quite new tool used in the biomonitoring, although they seem to be an easy, cheap method of bioindication which could work all-year–round. Thus, the comparison between these two tools (lichens and spider webs) is eligible and very important for efficient monitoring of air quality. We decided to compare the way of heavy metals accumulation in spider webs from Agelenidae family (*Eratigena atrica* and *Agelena labyrinthica*) and lichens *Hypogymnia physodes*, exposed for two months.

Keywords: spider webs ; lichens ; bioindicators ; biomonitoring ; heavy metals

1. Background

Monitoring of some regions e.g. mountain or woody might be sometimes difficult due to lack of access to electricity, altitude or limited access to people, hence the use of specialistic equipment is excluded. Another thing is that specialistic machines can be sometimes very expensive. However, mentioned problems can be solved by the use of living organisms or their products (biomonitors) found in the study area or tranplanted from clean areas into area of interest. The main advantage of biomonitors is that they are inexpensive and easily accesible which enhance the possibility of free planning of sampling points.

2. Lichens as Bioindicator

Biomonitoring of air pollutants with the application of lichens has become very popular over the years [3]. Lichens are an especially good tool for this purpose as they do not have a well-developed cuticle, and they also do not have roots that are able to absorb water and minerals since they are strictly dependent on atmospheric deposition [4]. Lichens have been successfully used for more than 30 years for the assessment of the atmospheric deposition of heavy metals in different areas [5][6].

In industrial or urban sites, the lichens occur rarely or are even absent, therefore the “bags technique” was developed and successfully applied [7]. Bags usually contain nylon mesh with water-washed lichens. The following advantages of this method are underlined: the exactly defined entrapment surface and time of exposure, the possibility of site selection, the defined initial concentrations of pollutants in lichens and general greater efficiency of samples collection, the exclusion of possible contamination deriving from root uptake, which is probable when we use dust fall jars or bulk samplers; and finally, this method is cheap and effective [5]. The biggest drawback of the bag method is that the collection efficiency for various contaminants is not defined. This was studied for mosses [8]. The authors suggest that data reflects relative rates of deposition but cannot be applied as the total atmospheric load of contaminants. Garty et al. [9] indicated another problem connected with applying this matrix, as it could reach a saturation point for the uptake of studied metal, thus, the further accumulation is not possible. Climate and other environmental conditions may also influence the results of biomonitoring with lichens.

3. Spider Webs as Bioindicator

On the other hand, spider webs are a quite new tool and they are not as commonly used as other bioindicators, although they are present almost everywhere [10][11][12][13][14]. Unlike lichens, they are common in the natural environment as well as in industrialized urban areas. Webs accumulate pollutants efficiently, therefore they are an excellent source of information on the environment quality.

The spider webs, suggested by us to be used in biomonitoring, are produced by spiders from Agelenidae family (*Eratigena atrica* (C.L. KOCH, 1843) and *Agelena labyrinthica* (CLERCK, 1757)). Webs woven by these spiders are built from irregular dense threads and have a form of horizontal flat sheet with a funnel-shaped tunnel where spider hides [1]. Even though the webs woven by Agelenids are dry and not sticky, its specific construction favors accumulation of the pollution.

The major advantages of webs' application are: common availability of webs, very convenient location (they are usually woven in secluded places) preventing them from being destroyed by weather conditions (rain, wind etc.), low cost, easy samples' collection and non-invasiveness of studies. Webs are also a non-specific and universal tool as they do not need any preparation before sampling. They are organic, natural and environment-friendly products which do not need to be degraded (no waste production, e.g., used sorbents). To define the exposure time the old web must be removed and using only a new construction is suggested, or applying the web obtained in the laboratory. Agelenidae do not eat their own web[2] therefore, obtaining the web from laboratory bred spiders is possible. Furthermore, obtained webs can be also used in any place in the same way as lichens or moss bags.

However, no investigations have focused on the comparison of the accumulation capacity of the two types of organisms so far. Therefore, the aim of our study was to compare these two bioindicators to assess their efficiency and relevance for the bioindication purposes. To accomplish this aim, we determined the selected metals in the vicinity of a copper smelter, which is known for its impact on the air and soil pollution in the studied region.

The entry showed that transplanted spider webs accumulated pollutants to the greater extent comparing to lichens which is a promising result when it comes to further application of spider webs as biomonitors. They could be not only used in the same way as lichens but they could be exposed shorter to obtain reliable results. The order of the accumulated elements was similar for both tools which indicates that the smelter plays an important role in air contamination in this region. To summarize, we recommend to apply webs in all the situations when the application of lichens is improper or impossible due to lichens limited uptake of analyzed elements, and during unfavorable weather conditions (for example: a drought or in winter time).

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