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Study on the metal absorption by two bryophytes from Koyana wildlife sanctuary (India)

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ABSTRACT: Two bryophyte species *Asterella angusta* Beauv. and *Cyathodium tuberosum* Kash. growing across different regions of Koyana wildlife sanctuary have been used as indicators of metal pollution. The estimation of important heavy metals like Cu, Zn, Pb, Ni, Cd and Cr have been carried out in the two bryophyte species using atomic absorption spectroscopy. The low level of metal pollutants was observed in moss specimens collected from the natural habitats and high level in the specimens collected from traffic areas. Overall, Cu and Pb are responsible for causing major pollution in the studied area and the concentration of metals in plant was found to be higher in study region.

Key words: Heavy metal, bryophytes, Sanctuary, traffic, *Asterella angusta, Cyathodium tuberosum*

Introduction

Bryophyte is a unique group of plants with remarkable ability to absorb heavy metals from the atmosphere. They play significant role as indicators of environmental pollution by the changes with respect to the dying rates, apparent injury, chlorophyll reduction and cell size reduction in leaf area. These are used as parameters for monitoring air pollution impacts on plant metabolism (Taoda, 1973, Rühling and Tyler, 1984, 2004). In recent years various applied aspects of bryophytes have thrown light, specifically as a bioindicator (Ando and Matsuo, 1984). However, uptake of metal ions in terrestrial environment is inconclusive because accumulation varies with season and time of collection of samples from the field (Kumar *et al.*, 1989). Analysis of the elemental content of mosses also gives the opportunity to investigate whether toxic elements might be responsible for the health effects observed in epidemiological studies (Basile *et al.* 2009). There are very few studies on uptake of metals by mosses and their role as bioindicators in urban terrestrial environment because of their narrow distribution range and less availability on account of various natural and anthropogenic reasons. From these evidences, it was thought worthwhile that the liverworts selected for these investigations may be similar to other bryophytes like mosses and can be good accumulators of microelements and will be useful in monitoring of pollution with metals. The main object of present study is to summarize the results and to compare the amount of metal concentration at various sites at different times and at different growth stages. Further it has also been extended to assess and to present the regional deposition pattern of heavy metal in the liverworts.

Materials and Methods

Koyana is the hilly locality in Western Ghats of Maharashtra (India) region and is found to be rich in hepatics. Despite of rich bryological flora in this region, negligible work has been done regarding them. In the present investigation the exploration of liverworts like *Asterella angusta* Beauv. and *Cyathodium tuberosum* Kash. from varied habitats. The areas which are categorized for the sake of our convenience into three synhabitats as Natural, Public and Traffic areas from locality. The specimens were dried in hot air oven for 24 hrs at 40°C. Five grams of material was taken and crushed with mortar and pestle. Estimation of the heavy metals in the plant samples was done by atomic absorption spectroscopy according to Allen (1989), using AAS (Perkin Elmer, 3030A). The analysis is done at young and mature stages to assess their metal tolerance potential. Keeping in view the role of mosses in metal accumulation and environmental monitors, the present study was undertaken in various regions of Koyana. The sites were chosen randomly across the study region. The estimation of metals was done in two moss species, *Asterella angusta* Beauv. and *Cyathodium tuberosum* Kash. growing in this region. The aim of the present study was to compare the amount of some metals detected in the varied habitats like natural, public and traffic areas of the study region.

Results

The assessment of the extent of deposition of heavy metals such as Cu, Zn, Pb, Ni Cd and Cr at different sites by bryophytes are shown in the fig. 1.

Fig. 1. The analysis of heavy metals in the thallus of liverworts *A. angusta* and *C. tuberosum* Koyana under different habitats

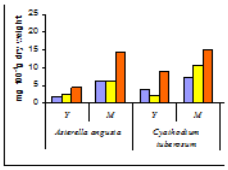

Fig. 1: Cu

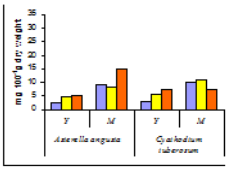

Fig. 1: Zn

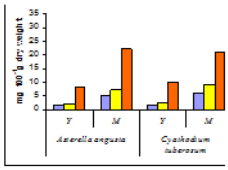

Fig. 1: Pb

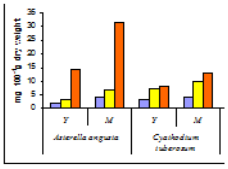

Fig. 1: Ni

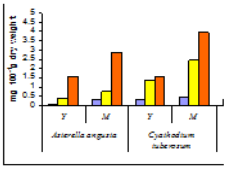

Fig. 1: Cd

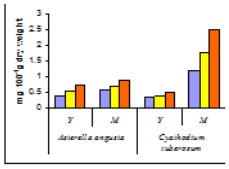

Fig. 1: Cr

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The accumulation of Cu in the thallus showed variations. Maximum uptake capacity of Cu is found in mature thallus of *C. tuberosum* in traffic areas than the *A. angusta.* The concentrations of Zn in the thallus of liverworts were varying. Maximum values of accumulation of Zn are recorded in mature thallus of *A. angusta* than the *C. tuberosum* at traffic areas of Koyana. The concentration is found to be increased in the mature stage, as Zn element does not remain constant throughout the year therefore interpretation of enrichment of Zn is complicated. Analysis of thallus for Pb shown that the accumulation of metal in the thallus tissue is also increasing from natural areas to traffic areas. Maximum accumulation has been recorded in mature thalli of *A. angustathan* than *C. tuberosum* in traffic areas of Koyana. Concentrations of Ni are increasing in the mature thallus than young thallus in liverworts. Maximum accumulation of Ni is recorded in mature thalli of *A. angusta* from traffic areas of while minimum accumulation is in the young thalli of *C. tuberosum* from natural areas. The sensitivity of Cd is increased in the young stage than mature and as a result there is reduction in thallus, along with slight increase in the concentration during mature stage. The thalli analysis showed that the *C. tuberosum* accumulated more Cd in mature thalli from traffic areas of Koyana and less in young thalli of *A. angusta* from natural areas of Panhala. Maximum accumulation of Cr is observed in the maure thalli of *C. tuberosum* of the traffic areas while minimum in the young thalli of *A. angusta* in natural areas.

Discussion

The metal concentrations in mosses are influenced by many factors such as the kind of metals emitted and the chemical and physical properties of the metalcontaining particles, for instance their size and acidity. In addition to the amount, quality and temporal development of the emission many edaphic and biological factors also regulate pollutant accumulation in the vegetation (Kozlov *et al.* 2000). Heavy metal concentration is distinctly associated with local emission point sources and changes in emission levels (Cao, *et al.* 2008). The solubility of heavy metals usually increases with decreasing pH. Some metals can also be substituted for others by ion exchange (Rühling and Tyler, 1970). The relative accumulation of different metals in a certain species may also vary with the total metal load (Ward *et al.* 1977). Major source of heavy metals in the urban areas are metallurgical processes, automobile exhaust emission, oil combustion and processing of crustal material. The presence of Cu, Zn, Pb, Ni Cd and Cr elements may seriously retard the potential colonization of polluted sites by bryophytes. It can be due to the fact that the liverworts can accumulate particulate matter over time and regional variations in the deposition of airborne metals reflected in the elemental composition of their tissues and surfaces (Groet, 1976). Ni, Cu, and Cr was found to be in highest range in both the moss species as compared to Pb and Cd. The lowest concentration of heavy metals was found in the natural places of the study region due to prominence of conserved area. The traffic region experienced high concentration of metals due to heavy traffic of vehicles amounting to high air pollution. Cu and Pb are responsible for the heavy metal pollution in both the plant sample of the sites studied in the study region. The uptake of heavy metals in mosses may certainly be influenced by climate, especially humidity and wind velocity. Different plant species show varying resistance to air borne and soil accumulated toxic elements, which is reflected in their growth survival and occurrence along the pollution gradient. However, the actual degree of exposure to toxic elements is not the same for all the plant species growing at the same distance from an emission source because of difference in the elemental uptake mechanisms (Zechmeister *et al.* 2003). The genetic make-up of the plant greatly influences its metal uptake potential. Huang *et al.* (1997) found that Pb accumulation varies significantly in different species grown in similar environments. The mobility and toxicity of heavy metals are strongly related to the acidity and organic matter contents of the soil (Alloway, 1990). It is concluded that Cu and Pb are responsible for causing pollution in the studied sites and higher accumulation of heavy metal concentration was shown by *A. angusta* due to larger leaf surface area and more tolerance capacity as compared to *C. tuberosum*. Lead is introduced into the atmosphere by exhaust fumes from vehicles, metal production and mining. The analysis of temporal and spatial trends in the heavy metal deposition is generally expressed as pollution gradient.

Conclusion

The present study reveals the content of heavy metals (Cu, Zn, Pb, Ni and Cd) in two moss species viz. *A. angusta* and *C. tuberosum* in different sites in the wildlife sanctuary. It appears that these metals are present well within the tolerance range of both the species. The study clearly depicts that for both the species, the substratum acts as a filter to take up more toxic metals such as Pb and Hg. Hence, these are not taken up by vegetative parts and remain concentrated in the substratum. Both the species grow successfully in the urban areas and form the dense carpet in moist and shady places especially in the winter. Our results show that both the species can accumulate large amount of metals. Thus, species can be used for monitoring the levels of metals in the given site and for phytoremediation.

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