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DETERMINATION OF HEAVY METALS IN LICHENS GROWING ON DIFFERENT ECOLOGICAL HABITATS IN SCHIRMACHER OASIS, EAST ANTARCTICA

Vivek Pandey & D.K. Upreti
National Botanical Research Institute, Lucknow

Introduction

Lichens are one of the most widely distributed group of organisms in the world, ranging from Arctic to Antarctic and from rocky shores of the sea to near the. summits of the highest mountains. Lichens are efficient accumulators of chemical elements which are taken up from substrate solutions, deposited aerosols, water vapour and rain. Their thalli particularly those with.soredia or. isidia provide an effective surface for uptake (Seaward, 1992). Recent studies suggest that there is global contamination of air, water and soil by trace metals (Nriagu and Pacyna, 1988). Several workers have suggested a possible role of lichens in pollution monitoring and biogeochemical studies (Tuominen and Jaakkola, 1973; Garty, 1993).

Until now, mainly foliose or fruticose lichen species, in particular epiphytes and terricolous ones, have been utilized as biomonitors of heavy metals (Garty, 1993). Furthermore, most of the studies took place in the northern hemisphere and generally in countries with a humid climate. A smaller number of publications exist on the accumulation of airborne heavy metals in lichens growing in arid or semi-arid zones.

Lichens are the major component of the Antarctic terrestrial flora, growing luxuriantly on rocks, boulders, moraine and decaying cushions of moss (Bryum species) tufts in ice-free areas. Data on heavy metal distribution in the Antarctic lichens are very scant, although some analyses have been done for heavy metals of snow and ice cores (Nizampurkar, 1988; Nizampurkar and Rao, 1988; Dick et al., 1990) and lichens (Upreti and Pandey, 1994).

The present study will provide a comparative account of metal content of different lichen thalli growing on different ecological habitats, in and around the Maitri Staion of the Schirmacher Oasis, East Antarctica.

Table 1. Different lichen species and their collection point

Species	Site
1. *Acarospora gwynii Dodge* and Rudolph	Around Zub lake
2. A. gwynii Dodge and Rudolph	Near 'Shivling' Nunatak
2. *Buellia grimmae* R. Filson	At base of Trishul hill
3. *B. pallida* Dodge and Baker	Before Trishul hill
5. *Lecanora expectans* Darb.	North of Zub lake
6. *L. fuscobrunnea* Dodge and Baker	Near Russian Station
7. *Lecidea cancriformis* Dodge and Baker	Behind flat top
8. *L. siplei* Dodge and Baker	North of Zub lake
9. *Rhizocarpon flavum* Dodge and Baker	South of Maitri near stream
10. *Rinodina olevaceobrunnea* Dodge and Baker	Near Russian Station
11. *Physcia caesia* (Hoffrn.) Hampe	East of Maitri, behind flat top
12. *Usnea antarctica* Du Rietz.	Vettiyya nunatak

Materials and methods

The lichen samples were collected from 11 localities in and around the Maitri area, Schirmacher Oasis (area about 34 km$^{2)}$ (Table 1). Samples were analyzed to determine the concentration of five metals (Cr, Cu, Fe, Pb and Zn). Whole thalli were collected and transported in hard brown-paper packets. The lichens were sorted and any particulate matter adhering to it was carefully removed under a dissecting microscope. Then samples were washed three times in deionized water by shaking for 15 min. After that they were air dried for 15 h. The material was then oven dried for a constant weight at 800C. The dried lichen samples (three replicates) were powdered (0.1 g) and digested in a mixture of concentrated HNO_3 and $HClO_4$ (v/v 3:1). Residues were filtered and diluted to desired volume with double distilled water. Metal content in the solution was analyzed by using a Perkin-Elmer 2380 Atomic Absorption Spectrophotometer.

Results and Discussions

As indicated in Table 2, all lichen species collected in and around the Maitri area have consistently higher amounts of iron and copper because of the substratum which is an iron and copper mineralized rock. Substratum plays a major role in determining the metal content of lichens (Brodo, 1973; Looney et al., 1985). It is interesting to note that the levels of iron in muscicolous (moss inhabiting) and cushion forming species of *Lecidea siplei* and *Rinodina olivaceobrunnea* are 17510 and 14240 ppm, respectively. While according to some workers the presence of a thick mossy mat blocks the direct contact of thalli with soil and affected metal availability (Goyal and Seaward, 1981). The other moss inhabiting species of *Lecanora* and *Buellia* accumulated more metals than their saxicolous (rock inhabitaing)species. There could be two reasons for this: (i) the dry climate of East Antarctica; and (ii) dry nature of rocks on which lichens were growing. Very high concentration of Fe and Cu have been reported in *Acarospora sinopica* and *Rhizocarpon oederi* growing on the 400-year-old hills of slag in smelting works. The same species growing on substrata proper in metals accumulated . smaller contents of those metals, reflecting the concentration of the associated sites (Lange and Ziegler, 1963).

Table 2. Heavy metal content of different lichen species

Species	Heavy metal content (Lig g-1 dry wt)			
	Cr	Zn	Cu	Fe
1. *Acarospora gwynnii*	19.28[l]–	12.42[k]	36.36"	6420"-[c]
2. *A. gwynnii*	97.87[b]	69.09"	124.84"	*8560*[cMx]
3. *Buellia grimmae*	57.75[c]	71.83[c]	395.38"	11290"'[i:]
4. *B. pallida*	54.76[c]-[d]	51.05*	138.88"	10070"-[c'd]
5. *Lecanora expectans*	60.38'	37.44'	53.29g	9420[c'd]
6. *L. fuscobrunnea*	25.35[c]	15.86J	59.95^	9820"'[cd]
7. *Lecidea cancriformis*	20.72e	44.71"	75.41'	4950"
8. *L. siplei*	56.12[td]	55.44'	237.41"	17510"
9. *Rhizocarpon flavum*	51.08[cd]	67.12"	96.56"	10040"'[t"]
10. *Rinodina olivaceobrunnea*	46,01"	71.44[c]	82.33'	14240""
11. *Physcia caesia*	106.66"	74.66"	100"	10350"-""
12. *Usnea antarctica*	122.39'	111.97"	166.66e	8840[c"'c]

Any two means in the column having a common letter are not significantly different at the 5% level of significance (Gomez and Gomez, 1984).

The patterns of metal localization within the different thallial components (rhizinae, medulla and phycobiont) have been studied and it has been demonstrated that the rhizinae and medulla play an important role in metal accumulation and translocation, especially at higher metal concentration, when the metal uptake capacity of the upper thallial surface is reduced (Goyal and Seaward, 1982). In the present study, the accumulation of Zn was less, probably due to the fact that some heavy metals (e.g. Zn and Mn) appear to be more mobile and their concentration may not necessarily be in direct relationship with the atmospheric deposition rates (Puckett et al., 1973; Goyal and Seaward, 1982). In the present study foliose

(Physcia caesia) and fruticose *(Usnea antarcria)* species accumulated higher quantities of metals than the crustose ones. The possible factro favouring the greater accumulation of metals in these two species, are the formation of felt-like structure on the substratum and the spongy nature due to dense subprostrate thallus libes or due to dense irregularly brached thallus. Out of the 12 species analyzed, only *Physcia caesia* has tufts of brached rhizine on the whole lower surface. It has been reported that the rhizinae play an important role in determining the accumulation within the thallus by icrease in rhizinal density and acting as a metallic reservoir (Goyal and Seaward, 1982).

Several authors have extensively documented the metal content of terricolous lichen thalli from different ecological situations (Tuominen and Jaakkola, 1973; Rao et al., 1977; Seaward et al.. 1978). In the present study, the difference in metal accumulatin in two samples of the same species of *Acarospora gwynnii* is probably due to their different habitat. As the moraine inhabiting sample have very high levels of metals in comparison to the sample from rocks in slops.

It is interesting to note that in the present study lead was not detected in any of the 12 samples while in an earlier documentation of the heavy metal contents of Umbilicaria aprina Nyl.and *U. decusata* (Vill.) Zablbr., collected near the bank of a Russian lake, the lead content was quite high (Upreti and Pandey, 1994). This suggests that the area in and around the Maitri station is relatively free from pollution.

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