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Chromium-Accumulating Bryophyte from New Caledonia

Abstract. Aerobryopsis longissima *(Doz. et Molk.) Fleisch, an epiphytic moss from New Caledonia, accumulates up to 7500 μg/g chromium. This species is the first chromium accumulator reported for bryophytes.*

Unusually high concentrations of several elements have been reported in bryophytes. For example, Erämetsä and Yliruokanen (1971) reported 4900 μg/g uranium in the ash of *Rhacomitrium lanuginosum* and Lounamaa (1956) published values of 6000 μg/g nickel in *Campylium polygamum* and 6000 μg/g copper and 10,000 μg/g zinc in *Rhacomitrium lanuginosum*.

In spite of unusually high concentrations of the above elements, no chromium-accumulating bryophyte has yet been reported, even for mosses growing over chromium-rich serpentine rocks. For example, in an investigation of the concentration of 33 elements in 38 species of bryophytes, Shacklette (1965) found an average of only 79 μg/g

TABLE 1. Chromium concentrations (µg/g) in *Aerobryopsis longissima* (Doz. et Molk.), in bark and leaves of the host *Homalium guillainii* (Vieill.) Briq. and in associated soils.

Site	Ash % of Dry Weight of Moss	Chromium Concentrations			
		Moss (ashed)	Bark (ashed)	Leaves (ashed)	Soil (dried)
1	4.0	7500	700		8600
2	9.7	6800	440		13200
3	8.0	5750	370		8800
4	10.7	6763	106		5800
5	11.7	2188	184		6400
6	10.0	1864	332		7000
7	11.5	3559	727		7600
8	10.5	3500	305		11000
Mean	8.1	4740	396	112[a]	8550
Std. Dev.	2.5	2226	222	61	2483

[a] Mean of 50 specimens.

chromium (expressed on an ash-weight basis). Lounamaa (1956) in a survey of 16 species, reported an average value of 99 µg/g with a maximum of 300 µg/g in two species.

In the course of a reconnaissance survey of the chemical composition of several New Caledonian mosses, we have discovered unusually high chromium accumulation in the epiphytic moss *Aerobryopsis longissima* (Doz. et Molk.) Fleisch. This common moss is found in dense humid forest. Our samples were collected in the Rivière Bleue area (annual precipitation ca. 2500 mm) about 30 km northeast of Nouméa. The forest grows over residual iron-rich soils on alluvia derived from peridotites and associated rocks. The moss is epiphytic on several hosts including *Homalium guillainii* (Vieill.) Briq., a small tree which is itself a hyperaccumulator of nickel and contains over 14% of this element in ashed leaves (Jaffré & Schmid, 1974). Results of our investigations are presented in this note.

Materials and Methods

Moss samples were collected at a height of about 2 m from the trunks of specimens of *Homalium guillainii.* The samples were washed for 30 min. in running tap water and were then rinsed in distilled water. The material was ashed at 500°C in pyrex beakers and 0.1 g samples of the ash were digested at 100°C with 10 ml amounts of 2 M hydrochloric acid until dissolution was complete. Samples of the leaves and bark of the host (*H. guillainii*) were also treated in exactly the same manner.

Soil samples from the base of the trees were dried at 105°C and 0.2 g samples were digested with 10 ml of a 1:1 mixture of concentrated nitric and hydrofluoric acids. Digestion was carried out in 50 ml polypropylene beakers suspended in a boiling water bath. The mixtures were dried and redissolved in 2 M hydrochloric acid.

Solutions of the moss, bark and soils were analysed for chromium by standard techniques of atomic absorption spectrophotometry. Results for samples collected from 8 separate sites are shown in Table 1. Data are for elemental chromium.

Results and Discussion

One of the main problems associated with the analysis of bryophytes is the elimination of contamination. This contamination may arise from the rooting medium or from wind-blown soil. It is almost impossible to remove bryophyte material completely from its substrate. Shacklette (1965) suggested that any ash percentage of dry weight above 10% should be treated as contamination. In our investigation, we have assumed that any excess over this limit is due to wind-blown contamination from the soil and not from the leaves or bark of *H. guillainii* (which always have a fairly low chromium content), and we have therefore recalculated values for mosses from four of the sites. This resulted in slightly lower values in three cases and a higher value in the fourth. It should be mentioned that corrections were made to the data in order to present results which were as conservative as possible, but it is not considered that contamination from the soil was likely because of the high rainfall, extent of the understory vegetation and the absence of strong winds in the thick forest.

The mean content of the eight specimens of *A. longissima* was nearly 5000 μg/g, which is easily the highest value ever reported for bryophytes. The high concentration in the moss compared with its host (on average nearly 20 times higher) poses interesting questions about mechanisms of translocation and of tolerance to chromium. One direct source of chromium is obviously drainage of chromium-rich solutions from the bark and their uptake by the root system of the moss. Possibly the high levels of chromium have been derived partly from water dripping from leaves—water that has been enriched with leaf exudates of leaves containing an appreciable amount of chromium. Even quite low concentrations of chromium in dripped water could be sufficient to cause high levels in the bryophytes because of loss of water by transpiration and retention of the chromium until it is excreted by senescence of the moss.

Another question of some importance is how the moss is able to tolerate such high concentrations of an element which is normally highly toxic to vegetation. It is clear that there is a need for biochemical studies on this species in order to seek an answer to the questions posed above.

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