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Short Communication

A Nickel-Accumulating Plant from Western Australia

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Summary. A small shrub *Hybanthus floribundus* (Lindl.) F. Muell. *Violaceae* growing in Western Australia accumulates nickel and cobalt to a very high degree. Values of up to 23% nickel in leaf ash may represent the highest relative accumulation of a metal on record. The high accumulation of nickel poses interesting problems in plant physiology and plant biochemistry.

An extensive literature exists on the accumulation of elements by vegetation. Because of the problems in plant physiology which are presented by abnormally-high elemental acumulations in plants, there has been an increasing interest in this field during the past decade.

We have discovered an unusual accumulation of nickel by the shrub *Hybanthus floribundus* (Lindl.) F. Muell, (Violac.), in the Eastern Goldfields area of Western Australia. Chemical analysis by atomic absorption spectrophotometry of several dozen species of plants from the area studied, revealed nickel values for *H. floribundus* which far exceeded those for any other plant sampled in the same areas. The highest value recorded was over 23% nickel in the ashed leaves. On a dry weight basis, the nickel content was over 1%. The soil in which the plants were growing contained an average of only 670 ppm of nickel.

H. floribundus also accumulates cobalt although the relative accumulation (concentration of an element in the plant divided by the concentration of the same element in the substrate) was significantly less than for nickel (140). Over 100 specimens of the plant were analysed for cobalt, nickel, calcium, chromium, copper, iron, manganese, magnesium, potassium, sodium, and zinc. Except for cobalt and nickel, the concentrations of these elements were the normal levels expected in vegetation (Cannon, 1960a). *H. floribundus* has no affinity for copper, the element most frequently accumulated by indicator plants (Duvigneaud, 1959).

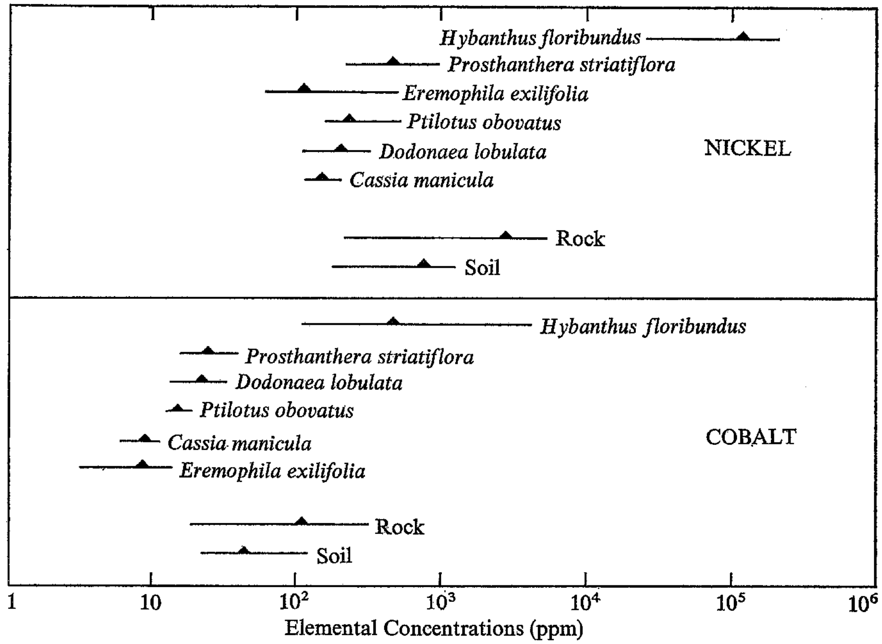

Fig. 1. Nickel and cobalt concentrations in shrubs, rocks and soils from the Eastern Goldfields area of Western Australia. The data demonstrate the high accumulation of these two elements by *Hybanthus floribundus* compared with other shrubs in the same general area. Peaks on the lines indicate median values

Table 1. *Elemental concentrations in the ash of accumulator plants compared with values for cobalt and nickel in Hybanthus floribundus*

Element	Species	Normal content (ppm) in plants (Cannon, 1960a)	Max. value recorded	Reference
Cobalt	*Crotalaria cobalticola*	9	18000	Duvigneaud (1959)
	Hybanthus floribundus	9	4000	This paper
Copper	*Becium homblei*	183	6300[a]	Reilly (1967)
Manganese	*Fucus vesiculosus*	4815	90000	Malyuga (1964)
Nickel	*Alyssum bertolonii*	65	100000	Minguzzi and Vergnano (1948)
	Hybanthus floribundus	65	230000	This paper
Selenium	*Astragalus pattersoni*	1	46000	Cannon (1960b)
Uranium	*Uncinia leptostachya*	1	25000	Whitehead and Brooks (1969)
Zinc	*Thlaspi calaminare*	1400	10000	Dorn (1937)

[a] Estimated from dry-weight data.

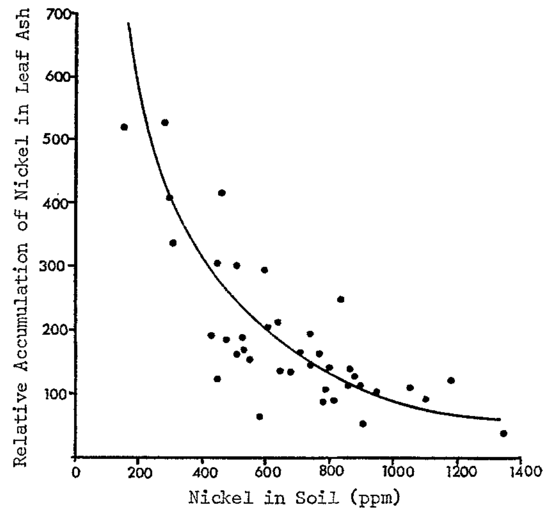

Fig. 2. Relative accumulation of nickel by leaf ash of *Hybanthus floribundus* (concentration in leaf ash divided by concentration in the soil) expressed as a function of the nickel content of the soil

Fig. 1 shows, on a logarithmic scale, cobalt and nickel values in the leaf ash of *H. floribundus* and in five other shrubs commonly found in the same general area.

Nearly all values for nickel lay within a narrow range of 400–3600 ppm in rocks, 240–1200 for soils and 4–16% in leaf ash of *H. floribundus*.

The degree of enrichment of nickel in this species is compared with some of the highest elemental accumulations recorded in the literature (values refer to concentrations in plant ash). The values for nickel in *H. floribundus* represent the highest values recorded for any element in the ash of land plants.

Has the plant a physiological need for cobalt and nickel or do the two metals exist as *ballast elements* (Frey-Wyssling, 1935)? Timperley *et al.* (1970) have shown that plots of the relative accumulation as a function of the concentration of an element in the substrate, are usually hyperbolic for essential elements and linear for non-essential elements. Fig. 2 shows that a plot of the relative accumulation of nickel in leaf ash of *H. floribundus*, as a function of the soil content of this element, is hyperbolic. Plots of this type usually approach a limiting value equivalent to the specific requirement for the element concerned. This quantity in Fig. 2 seems to be about 100 which corresponds to a value of about 100000 ppm (10%) in the plant ash. The plot does not prove that nickel is essential to the plant but does suggest that the above value is an approximately limiting amount for most specimens encountered.

The results reported in this paper are for the Eastern Goldfields area only, whereas *H. floribundus* is ubiquitous in Victoria, New South Wales, and South Australia as well as Western Australia. A specimen of *H. floribundus* collected from Mildura, Victoria, gave nickel and cobalt concentrations of only 300 and 100 ppm respectively for a substrate of unknown composition. The values for nickel are only slightly higher than normal background values and indicate that not all specimens of this plant have inordinately high concentrations of this element. The specimens we investigated in Western Australia may well be ecotypes adapted to the particular substrate encountered.

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