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STUDIES ON MANGANESE-ACCUMULATING *ALYXIA* SPECIES FROM NEW CALEDONIA

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Summary

Thirty-one species of *Alyxia* from New Caledonia were analysed for their manganese content. Most of the species showed excessive uptake of manganese with a maximum of 1.15% Mn in dried leaves of *A. rubricaulis*. The manganese content alone was sufficient to distinguish a number of species from each other. Composite samples were in addition analysed for calcium, magnesium, potassium and sodium. Correlation analysis and calculation of the slopes of regression lines showed that manganese uptake was mainly at the expense of calcium, rather than magnesium. Similarly magnesium was preferred to potassium and potassium to sodium. It is possible that manganese may have some physiological role in *Alyxia,* compensating to some extent for reduced uptake of the nutrients calcium and potassium.

Introduction

The manganese content of dried leaves of most plant species not growing over non-manganiferous substrates is typically of the order of 100 μg/g, whereas that of the soil is usually about 800–1,000 μg/g. Recently, Jaffré (1977, 1979) has found extremely high manganese levels in New Caledonia taxa growing on a wide variety of substrates. He reported (Jaffré, 1977) up to 3.2% manganese in dried leaves of *Maytenus bureauvianus* (Loes.) Loes. (Celastraceae) growing on basic hypermagnesian soils and 1.2% in *Alyxia rubricaulis* (H. Br.) Guillaumin growing on weathered acid soils. The respective manganese concentrations in the soils were 1.5% and 0.25%. In a later paper, Jaffré (1979) found even higher manganese levels in a number of Proteaceae including a massive 4.07% (5.18%) in the ash in leaves of *Macadamia neurophylla* (Guillaumin) Virot.

The presence of such high manganese concentrations in a number of New Caledonian genera raises the question as to whether other *hyperaccumulators* are to be found within them and also indicates the possibility of using these levels chemotaxonomically as an aid to species identification. Although *Maytenus* would seem to be a useful starting point for such a survey, it is unfortunately very difficult to identify this genus at the specific level, so that reference material contained at the O.R.S.T.O.M. herbarium Nouméa, New Caledonia is unreliable. By contrast, however, the Nouméa collection of about 30 species of *Alyxia* has been checked by Dr. P. Boiteau (P) as part of a forthcoming revision of the genus carried out in collaboration with Dr. L. Allorge (PC).

The following report is concerned with an investigation into the manganese content of *Alyxia* (mainly from New Caledonia) together with analyses of the material for

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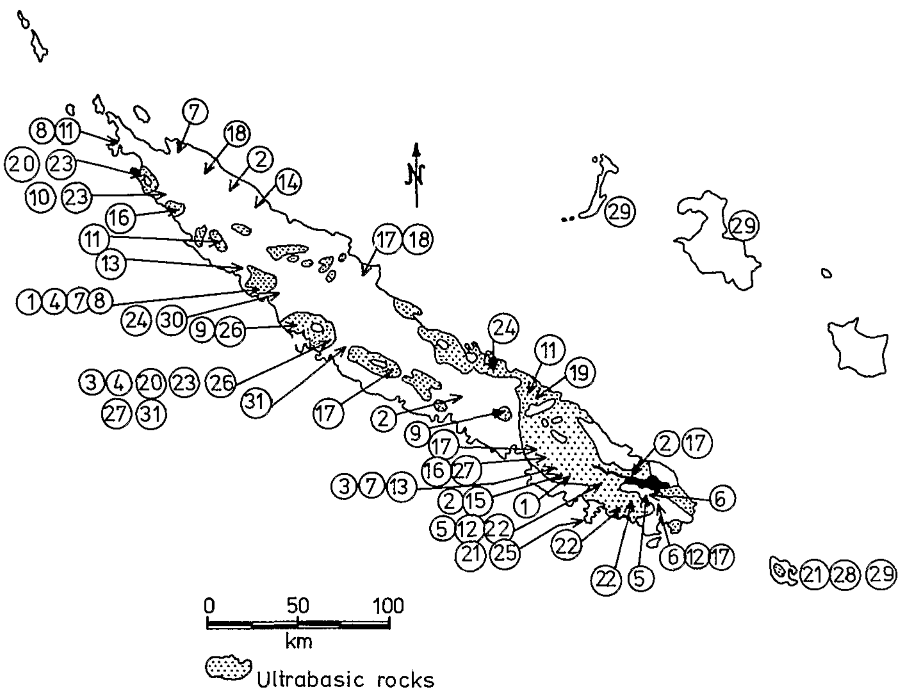

Fig. 1. Map of New Caledonia showing collection localities of *Alyxia* species. For numbering key see Fig. 2.

calcium, magnesium, potassium and sodium in order to study intraplant elemental relationships.

Materials and Methods

A total of 243 *Alyxia* specimens from 31 species held at the O.R.S.T.O.M. herbarium (NOU) was analysed. Two of these (*A. efatensis* and *A. stellata*) were from the New Hebrides and the rest were from New Caledonia.

Samples of an average mass of about 0.03 g (i.e. 1 cm^2) were placed in 5 ml borosilicate test-tubes and ignited at 500°C in a muffle furnace. The ash in each tube was then dissolved in 1 ml of 2 M hydrochloric acid prepared from redistilled reagent. The solutions were analyzed for manganese and other elements by atomic absorption spectrophotometry. Corrections for non-atomic absorption were made via a hydrogen continuum lamp. All concentration data were expressed on a dry-mass basis.

The collection localities are shown in Fig. 1. In this figure, the species are designated by numbers which correspond to plants listed in Fig. 2.

From Fig. 1 it is evident that most of the *Alyxia* species were collected from ultrabasic rocks. Manganese levels (Fig. 2) ranged downwards from a maximum of 1.15% in *A. rubricaulis* to a minimum of 0.0084% (84 μg/g) in *A. podocarpa*. It is clear from Fig. 2 that there is a steady variation in intraspecific manganese levels without however a discontinuity which might indicate an entirely new type of population of manganese accumulators. This is in contrast to hyperaccumulators of nickel (Brooks et al., 1977) which are separated from non-accumulator species by a concentration factor of at least ten.

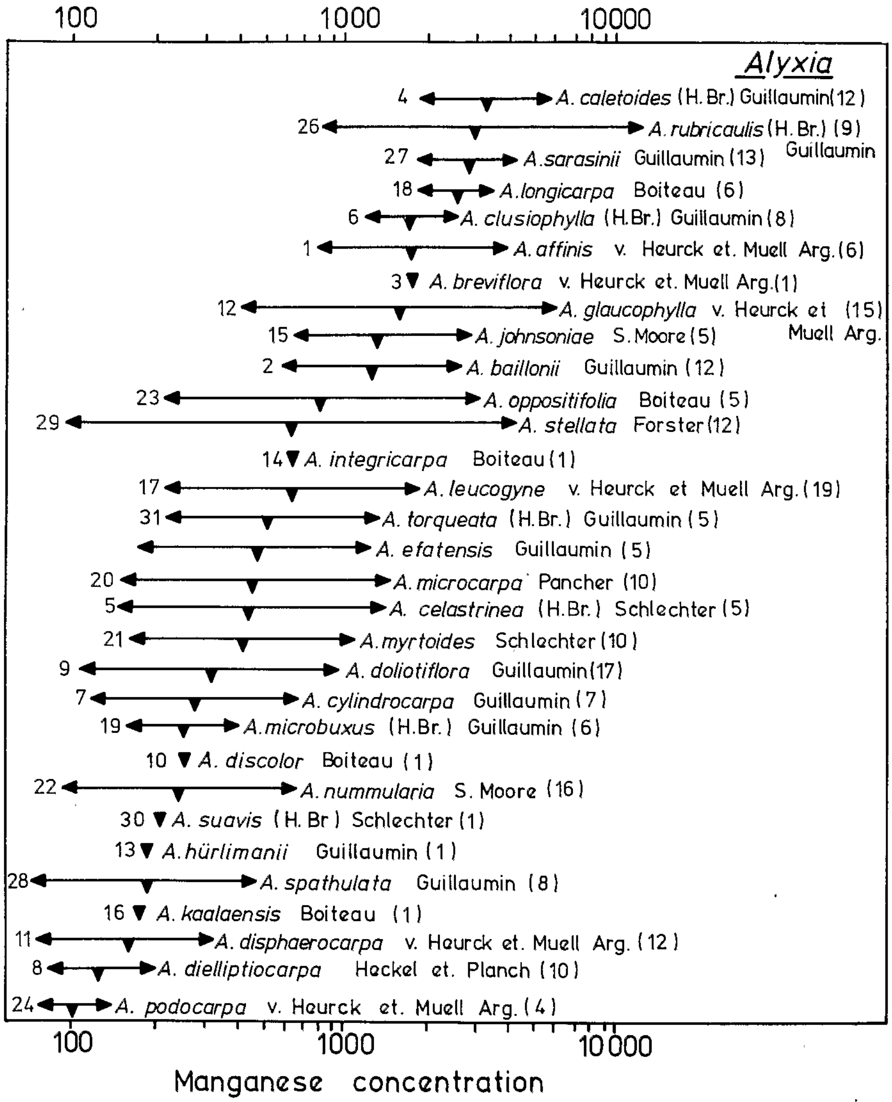

Fig. 2. Geometric means and standard deviations for manganese concentrations in *Alyxia* species. Numbers to the left of each plot are the numbering code used in Fig. 1. Numbers in parentheses refer to number of specimens analyzed.

Fig. 2 shows the geometric means and standard deviation ranges for each species studied. These values alone give some differentiation of species. For example *A. caletoides* is distinguishable from 19 other species on the basis of these data, and *A. podocarpa* is also separated from the same number of taxa. Composites of each of 24 *Alyxia* (7 of the 31 species did not have sufficient material for analysis) were prepared and analysed for calcium, magnesium, manganese, potassium and sodium. Correlation coefficients were calculated for each pair of elements within each group (i.e. 3 pairs per group). The findings are summarized in Table 1.

Table 1. Statistical data for elemental concentrations in *Alyxia*.

Group	Element correlated with Mn	Significance	Slope of regression line
1. Ca-Mg-Mn	Ca	S**	−0.91
	Mg	S*	−0.08
2. K-Mg-Mn	K	S**	−0.77
	Mg	S**	−0.63
3. Mg-Mn-Na	Mg	S**	−0.73
	Na	S**	−0.93
4. Ca-Mn-Na	Ca	S**	−0.80
5. Ca-K-Mn	Ca	S**	−0.78
6. K-Mn-Na	K	S*	−0.53
	Na	S**	−0.79

S** Very-highly significant, $P < 0.01$.
S* Highly significant, $0.01 > P \geqslant 0.001$.

The table shows only relationship involving manganese and only those which are at least highly significant ($P < 0.01$). It is obvious that an increase in the manganese level in plant material must at the same time result in the diminution of the concentration of another constituent. This is clearly shown in the table by the negative values of the regression lines. Differences in the gradients of these lines do, however, give information of the relative competition between manganese and any other pair of elements. In group 1, manganese uptake among the 24 species of *Alyxia* is apparently mainly at the expense of calcium rather than magnesium. Similarly magnesium is preferred to potassium (group 2) and to sodium (group 3). In group 6 potassium is preferred to sodium.

The fall in relative levels of the nutrients calcium and potassium compared with magnesium may be due in part to the available levels of these elements in the substrate which tends to become progressively more ultrabasic as the manganese levels in the plants increase. There is, however, the possibility that manganese fulfills a physiological role in these plants and is able to replace calcium and/or potassium to some extent.

Although this work has been centred around *Alyxia,* there is no reason why a similar procedure should not be applied to other genera, particularly those which present severe classification problems. A good example of this is *Maytenus* (Celastraceae) which contains a number of New Caledonia species with even higher manganese levels than *Alyxia*. To date our work on this genus has been hampered by problems of identification of suitable reference material, but when these have been overcome, our studies will be extended further.

References

Brooks, R. R., J. Lee, R. D. Reeves and T. Jaffré. 1977. Detection of nickeliferous rocks by analysis of herbarium specimens of indicator plants. *J. Geochem. Explor.* 7: 49–57.

Jaffré, T. 1977. Accumulation du manganèse par des espèces associés aux terrains ultrabasiques de Nouvelle-Calédonie. *Compt. Rend. Acad. Sci. Paris Sér. D,* 284: 1573–1575.

———. 1979. Accumulation du manganèse par les Protéacées de Nouvelle-Calédonie. *Compt. Rend. Acad. Sci. Paris Sér. D,* 289: 425–428.