Observations on Average Trunk Diameters of *Eucalyptus cunninghamii* (Myrtaceae) in Relation to Elemental Concentrations of their Substrates

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The rare *Eucalyptus cunninghamii* Sweet (Myrtaceae), the Cliff Mallee Ash, inhabits a geological niche associated with claystones, most often the Wentworth Falls Claystone Member of the Narrabeen Group. We show that some gross morphological attributes of *E cunninghamii* vary widely and that they are determined by elemental composition of its claystone substrate. We examined eight widely separated specimens and their substrates in the upper Blue Mountains of New South Wales and found that concentrations of thirteen elements in those substrates varied widely, mostly following a linear pattern. We also found that average trunk diameter of each specimen correlated strongly with most of the elemental concentrations in its substrate, and that average trunk diameter was therefore a good guide to the nutrient status of its substrate. Concentrations of potassium and phosphorus both varied by an order of magnitude.

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KEYWORDS: Blue Mountains, claystone, cunninghamii, elemental analysis, Eucalyptus, phosphorus, potassium, substrate, trunks, Wentworth Falls.

INTRODUCTION

The rare *Eucalyptus cunninghamii* Sweet (Myrtaceae), the Cliff Mallee Ash, inhabits a geological niche in association with a layer of claystone (Coleby and Druitt 2019). Around the clifftop rims of the Grose and Jamison Valleys of the upper Blue Mountains of New South Wales *E cunninghamii* varies from a dwarf tree 0.5 m high to a substantial tree over 5 m high (pers. obs.), whereas other authors state up to 2 m (Fairley 2004, Carolin and Tindale 1994) and up to 3 m (Slee et al. 2015). Canopy width and average trunk diameters follow a similar pattern, but the number of trunks diminishes with tree height. Here we sampled eight mature trees from a range of habitats and, for each, examined the connection between its morphological attributes and elemental concentrations in its substrate.

METHODS

We collected morphological data from eight mature trees identified in an earlier study (Coleby and Druitt 2019). Soil samples from underneath the lignotubers of these eight mature trees were air dried for five days and then oven-dried for 72 hours at 80^{o}C. Analyses for thirteen elements in each sample were carried out by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES) in Isotope Tracing in Natural Systems (ITNS) at the Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Heights, Sydney. We correlated concentrations of thirteen elements from those samples with gross morphological attributes: leaf length, leaf width, leaf length-to-width ratio, tree height and average trunk diameter.

Table 1. Morphological attributes of eight selected trees of *Eucalyptus cunninghamii* from the upper Blue Mountains of NSW. See Coleby and Druitt (2019) for details of Latitude and Longitude of Occurrences and Codes.

Occurrence	Code	Tree Height (m)	Trunks No.	Trunks Ave. Dia. (mm)	Leaves Ave. Length (mm)	Leaves Ave. width (mm)	Leaves Length/ Width Ratio
Butterbox East	BE	0.5	7	13	21.9	3.0	7.4
Butterbox South	BS	0.8	5	15	32.2	4.2	7.7
Mount Banks 1	MB1	0.9	10	21	41	4	10.3
Fortress Cliff	FC	1.7	5	23	35.3	4.5	7.8
Pulpit Rock	PR	2	7	25	38.3	4.3	8.9
Sublime Point	SP	2.3	3	35	50.5	4.9	10.3
Kedumba Road	KR	2.5	2	50	44.4	4	11.1
Kedumba Gate	KG	2.8	2	80	41.6	4.2	9.9

RESULTS AND DISCUSSION

Some morphological attributes of the eight mature trees that we sampled in the upper Blue Mountains are shown in Table 1. Five of these trees derived from the Grose Valley, three from the Jamison Valley. Leaf width ranged from 3.0 mm to 4.9 mm, leaf length from 21.9 mm to 50.5 mm, and leaf length to width ratio ranged from 7.4 to 11.1. Tree height ranged from 0.5 m to 2.8 m, the number of trunks ranged from 2 to 10, and average trunk diameter ranged from 13 mm to 80 mm. These large variations in morphological attributes of mature trees are unusual for eucalypts, and more so because they occur over a total north-south range of 22 km and an east-west range of 9 km in the upper Blue Mountains (ignoring a small outlier 80 km south at Wanganderry Walls near Mittagong).

We found that there was little correlation between soil elements and leaf width (average correlation coefficient 0.20), and better correlation with leaf length (average 0.54). Correlation between soil elements and the ratio of leaf length to width was higher (average 0.65). The correlation with number of trunks on each tree was moderate (average -0.57), but with tree height was higher (average 0.76). The most significant correlation coefficient of soil elemental analyses at the eight occurrences was with average trunk diameter (average correlation coefficient 0.85). Of the 13 elements in the analyses (Table 2) nine exhibited a correlation coefficient of 0.90 or higher (Al, 0.95; Ba, 0.96; Cu, 1.00; K, 0.98; Mg, 0.95; Mn, 0.95; P, 0.99; Sr, 0.94; and Zn, 0.90).

Only four elements exhibited a correlation coefficient lower than 0.90 (Ca, 0.39; Fe, 0.85; Na, 0.61; and S, 0.59). Soil analyses at Kedumba Gate were low in calcium, sulphur and sodium; iron and zinc at Mt Banks were high; strontium at Fortress Cliff was also high. These six unexplained variations partly gave rise to the four low correlation coefficients.

The major finding is that there appears to be a positive linear relationship between average trunk diameter of each tree and most of the elemental concentrations in its substrate. As examples we graph elemental concentrations vs trunk diameters for potassium (Figure 1a) and for phosphorus (Figure 1b): elemental concentrations both range over an order of magnitude, and average trunk diameters varied by a factor of five. Average trunk diameters per tree are a reliable guide to relative elemental status of soils on which *E cunninghamii* grows.

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Table 2. Correlation coefficients of average trunk diameters with ANSTO elemental analyses of substrate for eight selected trees of *Eucalyptus cunninghamii* in the upper Blue Mountains of NSW. See Coleby and Druitt (2019) for Latitude and Longitude of Occurrences and Codes.

Diameter of Trunks (mm)	**Occurrence**	**Code**	**Al**	**Ba**	**Ca**	**Cu**	**Fe**	**K**	**Mg**	**Mn**	**Na**	**P**	**S**	**Sr**	**Zn**
						ANSTO Elemental Analyses (mg/kg)									
13	Butterbox East	BE	4250	17.3	50	1	3370	479	100	5.2	29	43	79	13.3	3.4
15	Butterbox South	BS	1720	8.2	27	1	783	238	53.8	2	28	33	49	10	2.3
21	Fortress Cliff	FC	8720	81.4	92	3.2	10800	861	250	6.1	59	143	106	48.3	6.3
23	Mount Banks	MB	11400	23.9	105	2.6	13800	864	259	13.4	38	86	169	19.2	13.5
25	Pulpit Rock	PR	7720	47.8	386	2.4	4310	871	278	13.8	50	92	111	23.5	7.9
35	Sublime Point	SP	11200	72.5	101	5	9430	1100	368	15	77	127	162	34.4	9.3
50	Kedumba Road	KR	15300	117	662	10.3	17500	1690	449	59.2	87	242	358	58.7	16.2
80	Kedumba Gate	KG	25500	389	175	16.9	22100	2450	678	24.1	63	403	181	89.4	21.7
Correlation Coefficients of Trunk Diameters (mm) with Elemental Analyses			0.95	0.96	0.40	1.00	0.86	0.98	0.95	0.95	0.60	0.99	0.58	0.94	0.90

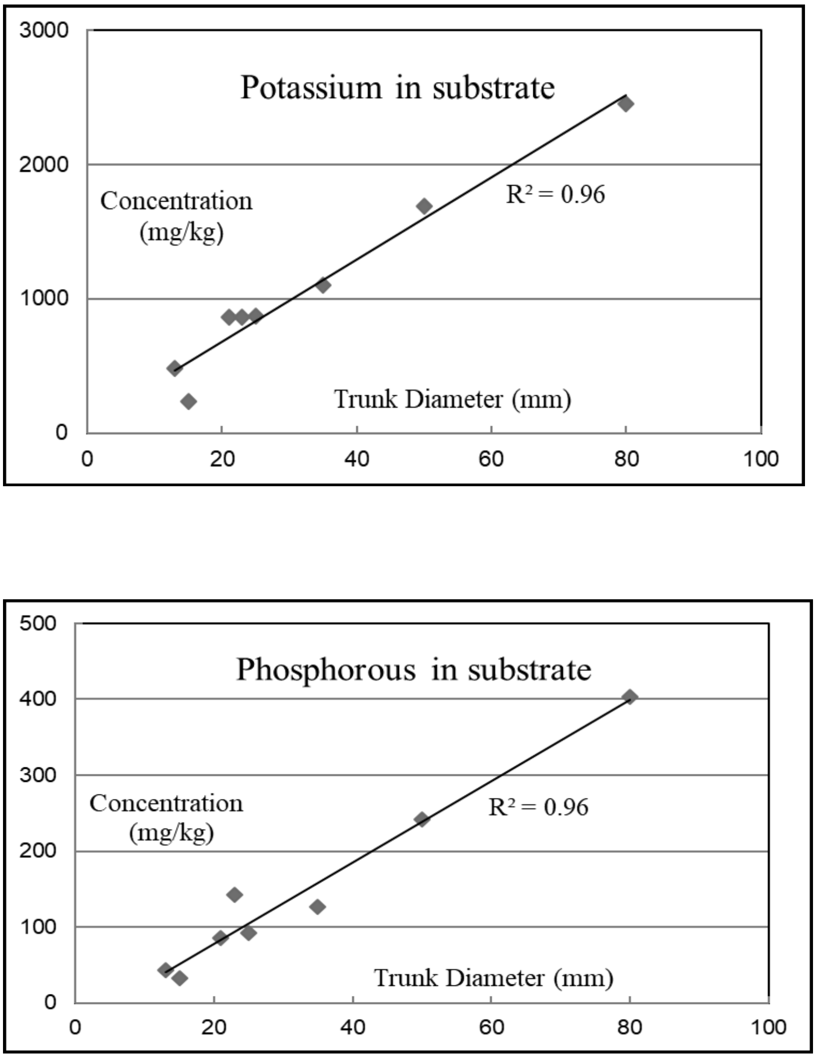

Figure 1. Graphs of elemental concentrations in soil vs average trunk diameter at eight selected occurrences of *Eucalyptus cunninghamii* in the Grose and Jamison Valleys of the upper Blue Mountains of NSW: 1a. potassium, 1b. phosphorus.)

REFERENCES

Carolin, R.C., and Tindale, M.D. (1994), Flora of the Sydney Region, Reed, Sydney. ISBN 0730 104001

Coleby, D., and Druitt, R. (2019) *Eucalyptus cunninghamii in the Blue Mountains of NSW – an Unexpected Connection between Botany and Geology*, Proceedings of the Linnean Society of NSW, **141**, 81–95.

Fairley, A. (2004), *Seldom Seen, Rare Plants of Greater Sydney*, Reed New Holland, Sydney. ISBN 1 876334 99 1

Slee, A. V., Brooker M. I. H., Duffy, S. M., and West, J. G. (2015), *EUCLID – Eucalypts of Australia*, 4th Edition, (Internet), CSIRO Publishing, Melbourne. http://keyserver.lucidcentral.org:8080/euclid/data/02050e02-0108-490e-89000e0601070d00/media/Html/Eucalyptus_cunninghamii.htm