# When Monitoring for Metals Beware of Hairy Plants

**Can we really believe what we measure in plants as indictors of Pb contamination? A range of leaf morphologies in native Australian plants may differentially capture windblown Pb on their surfaces leading to highly variable results unrelated to plant uptake**

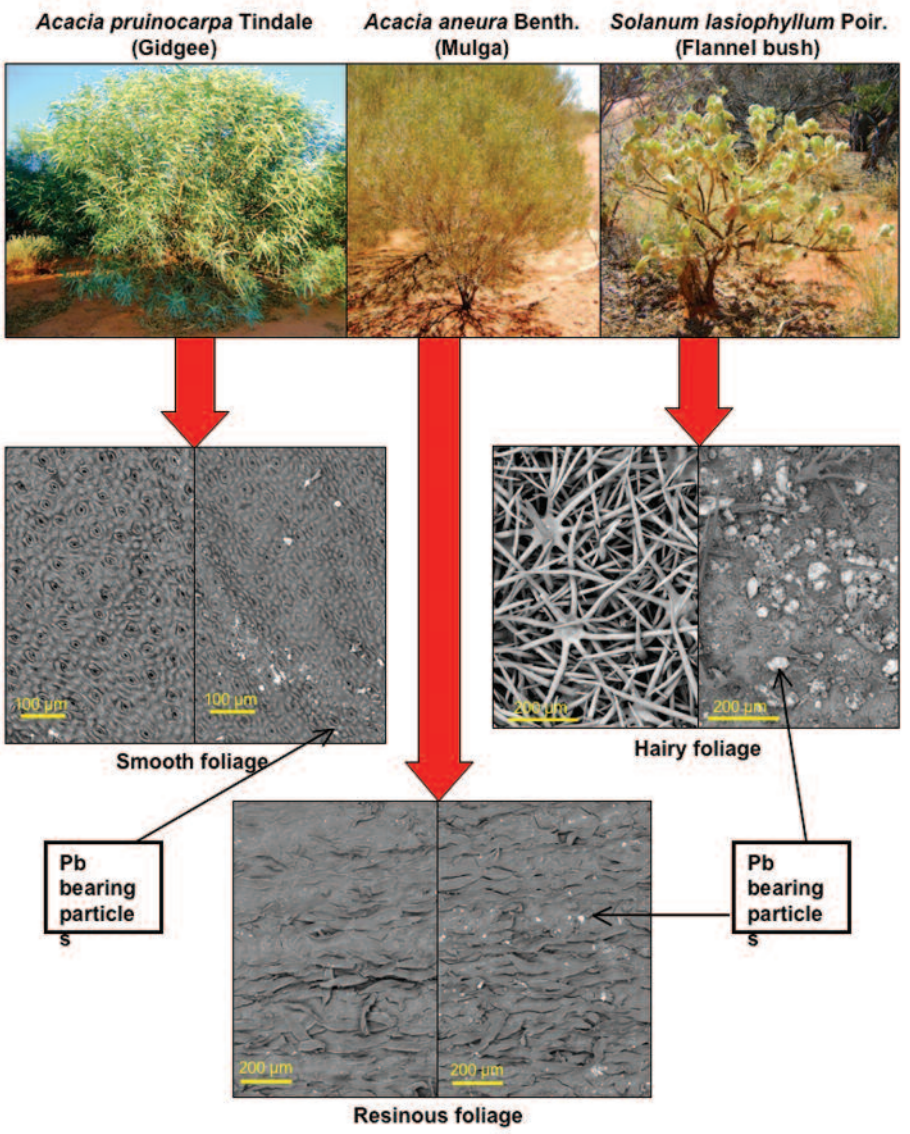
> *"Soil conditions and rhizosphere microbiology, including mycorrhizas, are poorly understood in this context, so much remains to be elucidated."*

In the arid wilderness of Western Australia, on the edge of the Great Victoria Desert, lies a unique deposit of lead carbonate minerals known as the Magellan deposit. The high lead (Pb) content of this deposit makes it a valuable resource and mining began there in 2005. Because Pb is toxic to living organisms, strict conditions were imposed on mining operations to ensure the health and safety of employees working at the mine and also the local environment. One of these conditions requires the mining company to monitor the local vegetation to determine if mining operations result in any adverse effects on it and if any Pb metabolism attributable to the mine is occurring in the tissues of local plants. These local plants are quite unique and have wonderful local names such as Gidgee (Acacia pruinocarpa), Mulga (Acacia aneura) and Flannel bush (Solanum lasiophyllum) (Figure 1).

Early monitoring produced results that indicated very high Pb uptake in some plants in some localities surrounding the mine. In fact, some plants appeared to have assimilated Pb concentrations beyond what would normally be considered lethal. As it is possible for some plants to hyperaccumulate Pb the research team considered this option but the likely culprit of these spurious results seemed to be Pb laden dust contamination of plant tissue surfaces. Despite basic attempts to wash the leaves clean for analysis, the results from monitoring regimes remained stubbornly and unpredictably variable and, occasionally, exceedingly high. To explore this phenomenon in more detail, the mining company invited Professor Mark Tibbett of Cranfield University, and his team of local researchers at the University of Western Australia to investigate further.

The research team knew that the leaf surfaces were very different in these plants (Figure 1) and could be either smooth resinous or hairy. To begin with the team undertook a field sampling programme and collected plant leaves of the selected test species close to and more distant from the mine site. To determine the extent of surficial Pb contamination on the plants (relative to Pb assimilated by the plant roots from the soil) the research team followed two related and complimentary approaches. Firstly, leaf samples were subjected to a range of separate washing treatments that were either 0.01 mol l-1 EDTA, 1% Citranox™ solution, milli-Q de-ionised water, or no washing at all. After washing, dried leaf samples and aliquots of washing solutions were analysed for Pb by inductively coupled plasma optical emission spectroscopy. Secondly, washed and unwashed foliage samples were examined under a scanning electron microscope and energy dispersive x-ray spectrometry was used to identify any surface dust particles containing Pb (figure 1).

The finding of the study showed that washing leaves consistently reduced foliar Pb measurements with hairy leaves releasing considerable Pb into the washing solution (Figure 2) but this varied with plant type and washing solution. In fact, despite trying several washing treatments, surface contamination remained on every leaf surface to some extent, regardless of leaf type. As one might anticipate, overall

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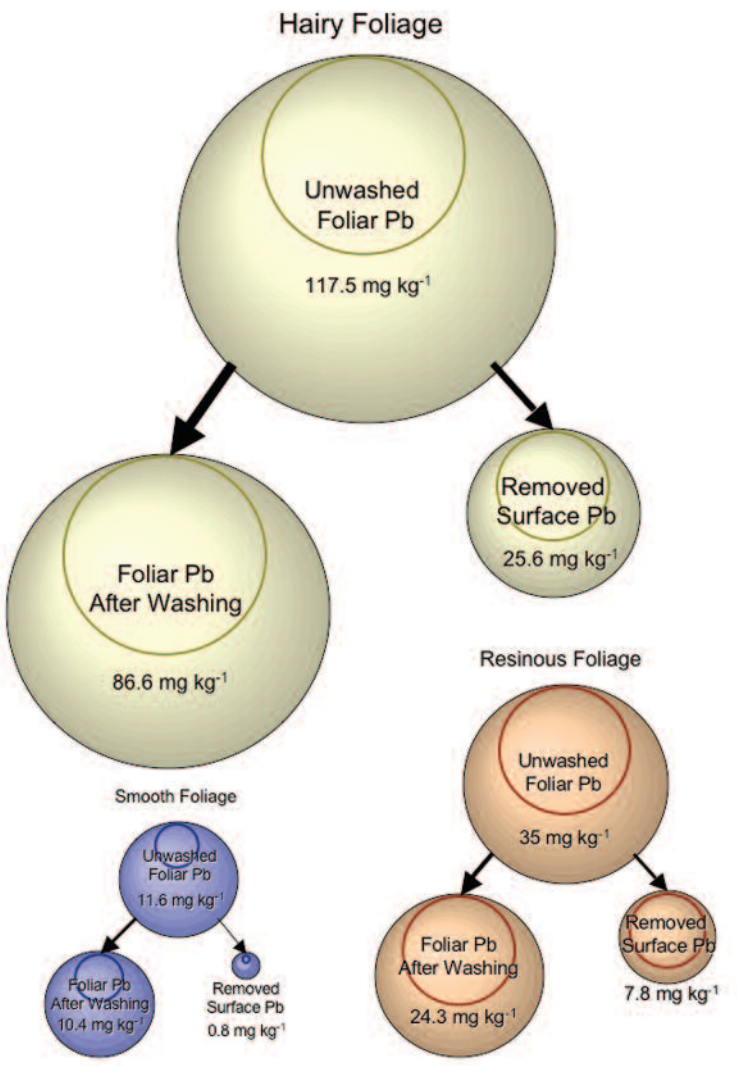


Spheres represent mean Pb concentrations for each fraction across all sites. Circles within spheres represent one standard error of the corresponding mean.

foliar Pb concentrations were strongly affected by leaf surface characteristics and by the proximity of plants to the mine. The hairy leaved plants where most effective at trapping airborne dust particles, and in these plants foliar Pb concentrations were considerably higher in individuals growing closer to the mine site. The palm shaped leaf hairs in these plants not only trapped airborne dust but retained it at the leaf surface during washing, effectively preventing its removal; so if the Pb content of the dust was high, so too was the foliar Pb measurement, thereby providing a misleading estimate of true plant concentration (as opposed to surface contamination). Pb content in plants with resinous leaves was also higher in individuals growing closer to the mine, but surface resins did not retain airborne contamination to the degree that leaf hairs did. Smooth leaved plants returned low foliar Pb concentrations irrespective of whether they were growing close to the mine or away from it, thereby providing a more realistic estimate of true plant concentration. The results suggest that plants with hairy leaves probably provide a better indication of surface Pb contamination whereas plants with smooth leaves may provide more realistic clues regarding Pb uptake by the plant from the soil. Unexpectedly these finding may help structure future monitoring regimes to better determine, and partition, contaminated dust pollution versus bioavailable soil contamination as a result of mining activities.

There remains much we currently do not know about Pb lead uptake in these plants. Some plants may naturally exclude Pb whereas others may tend toward accumulation of the metal in their shoot tissues. Soil conditions and rhizosphere


microbiology, including mycorrhizas, are poorly understood in this context, so much remains to be elucidated. The next steps in this research will be aimed at developing a way of discriminating between Pb adhered to plant tissue surfaces and the internal, metabolised Pb fraction. This will involve determining mineralogical provenance of Pb from mine waste source as opposed to soil borne sources to allow mining related dust contamination to be identified; and physiological studies of plant Pb metabolism under controlled conditions where Pb uptake can be precisely monitored, to allow true Pb assimilation rates to be clearly ascertained.