# Adaptations of Plants Growing in Metal Contaminated Soils

Authors: Hans Bogenrief, Adwoa Odoom, and Libby Horwitz; Adviser: Dr. Anne Su

## INTRODUCTION

Metal contamination in soils has increased due to decades of industry. However, many plant species have shown resilience to metal contamination, and some have adapted to this resilience in their favor to protect themselves from predators. This study analyzes current research on display that shows mechanisms and adaptations that plants have developed to resist or utilize metal contaminants such as Pb, As, Hg, & Cd.

## METHODS

Sources were obtained through literature and academic journal search over the internet by using Google Scholar. Search was focused on metal contamination and plant physiological reactions to metal contamination and methods to remediate intake of metals toxic to plants.

Figure 1: Photo of Hydrangeas, an Al hyperaccumulator, in one of Cleveland State's Biology labs. Photo taken by Hans Bogenrief.

## RESULTS

- The intake of heavy metals in contaminated soils is controlled by two different means: heavy metal *exclusion* and heavy metal ***hyperaccumulation***.

## RESULTS (cont.)

### Excluder Plants

- Excluder/hypertolerant plants are able to grow within heavy metal contaminated soils by holding most contaminants on a root-based level. Within the root cells, metals will enter into the cells that would normally be taken to the shoot or leaves of the plant would now be isolated in the apoplasts and binded to exuded amino acids or anions; if the metals do enter the membrane of the root cells, they bind to any several kinds of polymers or are sequestered in the vacuole. While this does not entirely prevent heavy metals traveling through the roots to the body of the plant, this will keep the concentration much lower and detoxify within the roots. (Rascio and Navari-Izzo, 2010).

### Hyperaccumulator Plants

- Hyperaccumulator plants, sometimes referred to as metallicolous plants, are species of plants that take in high amounts of heavy metals into their leaves and shoots without the effects of phytotoxicity. What sets hyperaccumulators apart from other plants are three criteria: uptake of heavy metals through the roots, translocation of these metals from the roots to the shoots, and detoxification and/or sequestration which happens within the leaves, epidermis, and trichomes (Rascio and Navari-Izzo, 2010).
- Currently, the main hypothesis as to why this has evolved is it is a defensive mechanism against herbivores and pathogens; however, hyperaccumulation does have other effects such as in hydrangea with aluminum in acidic soil changing the colors of the sepals to blue (Rascio and Navari-Izzo, 2010; Chen et al, 2015).
- There have been uses realized through hyperaccumulation, such as *phytoremediation*, the process of extracting heavy metals from contaminated soils as a way of environmental cleanup, or *phytomining*, also known as *agromining*, a process of using hyperaccumulator plants to take up heavy metals to process and extract them from the plant for other uses. As of 2018, there have been plant species that accumulate Ni, Zn, Cu, Cd, Pb, Co, Mn, As, and Tl; there has also been a plant growth promoting bacteria resistant to heavy metals that has been tested on the Castor Bean plant, an excellent hyperaccumulator of Zn, Ni, and Cu (Rascio and Navari-Izzo, 2010; Reeves et al, 2018; Rajkumar and Freitas, 2007).

Figure 2: The Castor Bean Plant, a Zn, Ni, and Cu hyperaccumulator. https://commons.wikimedia.org/wiki/File:Ricinus_March_2010-1.jpg

## CONCLUSION & FUTURE WORK

Plants resistant to heavy metals are still few as these adaptations aren't universal- less than 0.2% of all plant species are hyperaccumulators (Rascio and Navari-Izzo, 2010). Succession in metal contaminated soils is possible, as seen in Liberty State Park, but it generally results in "arrested succession," where abiotic stressors are intensified and reinforced and as a result set the entire ecological community behind by stagnation (Gallagher et al, 2014). Regardless, the evolutionary adaptation that have been observed are remarkable and can be utilized through phytoremediation and agromining. Further research can be done in order to find which plants will be the most effective for either task and how these mechanisms and processes can be improved.

### References

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