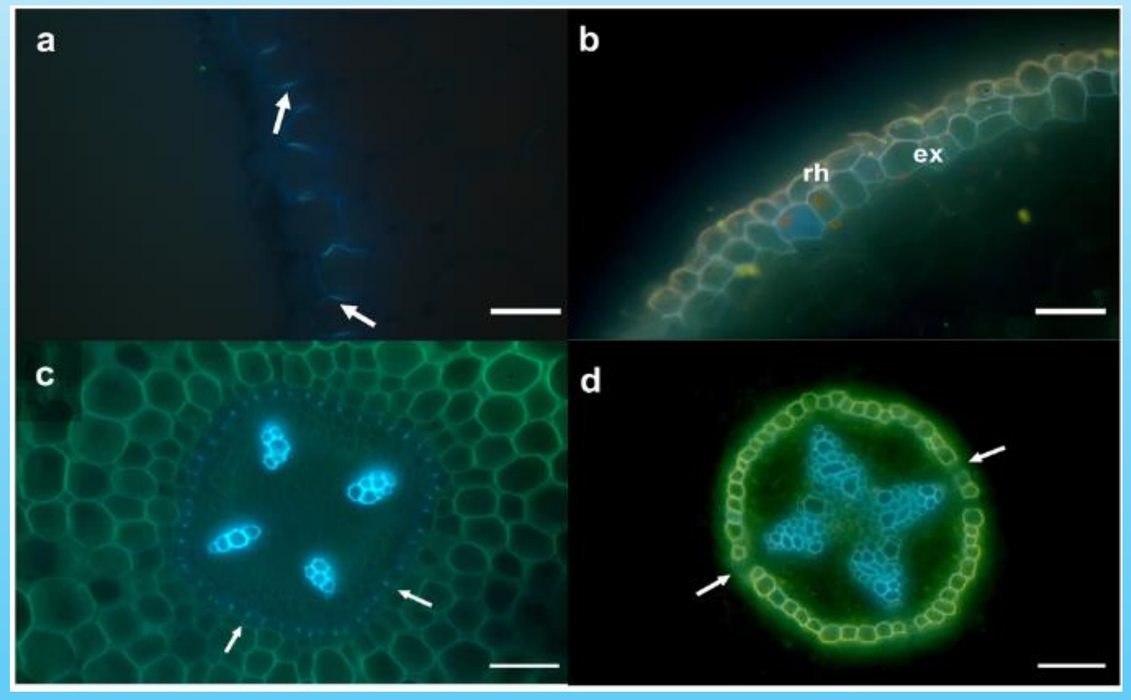
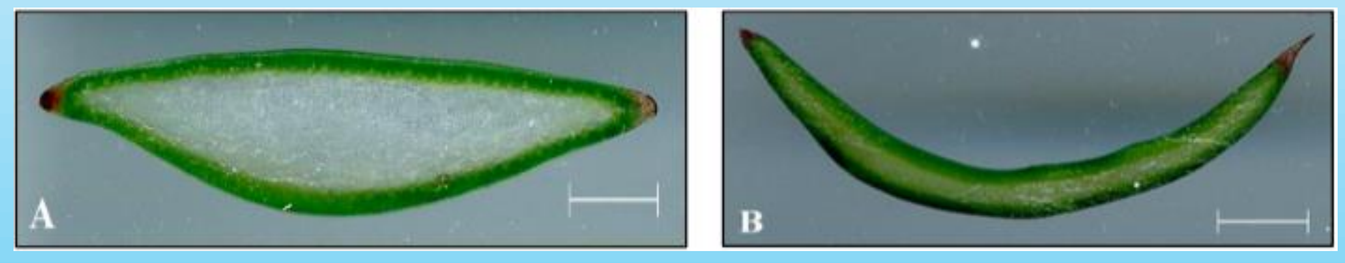
How heavy metals and metalloids can affect plant tissue structure?



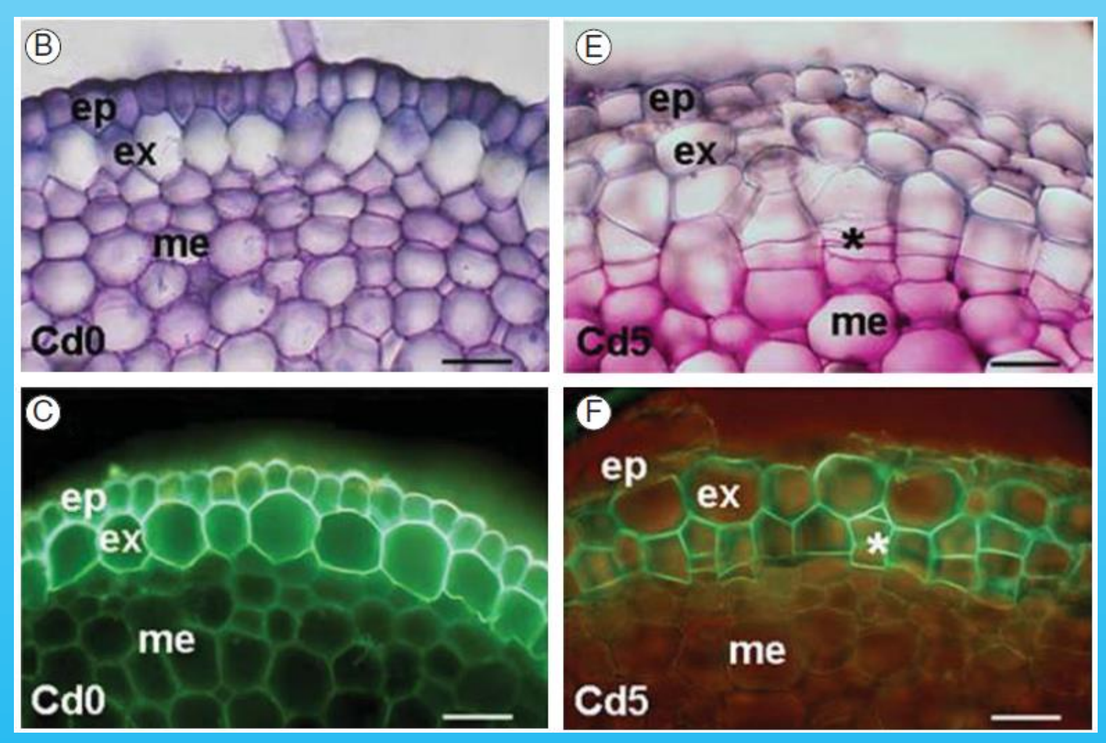
Root exodermis and endodermis have role of barriers or checkpoints that control the apoplasmic uptake of elements, including metals and metalloids into the central cylinder and from there via xylem to the shoot. Several reports have shown that metals and metalloids can shifted the development of both Casparian bands (Fig. A and C) and suberin lamellae (Fig. B,D) in exo- and endodermis towards the root apex.

(Vaculik et al., 2012, Environ Pollut 163, 117-126)



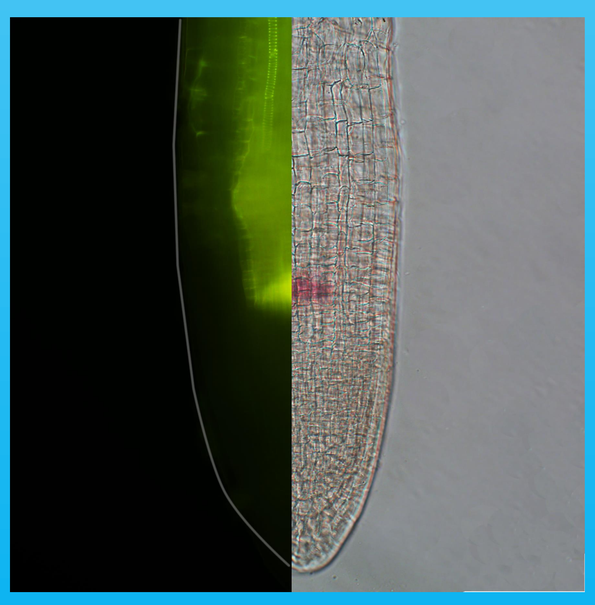
Presence of metals and metalloids can highly affect leaf morphology and anatomy, and proportion of individual tissues can be significantly modified. Compared to control untreated leaf (Fig. A), cadmium reduced the inner jelly part of *Aloe ferox* leaf, the area formed by hydrenchymatous cells (Fig. B).

(Šírová & Vaculík, 2022, South Afr J Bot 147 , 1181 - 1187)



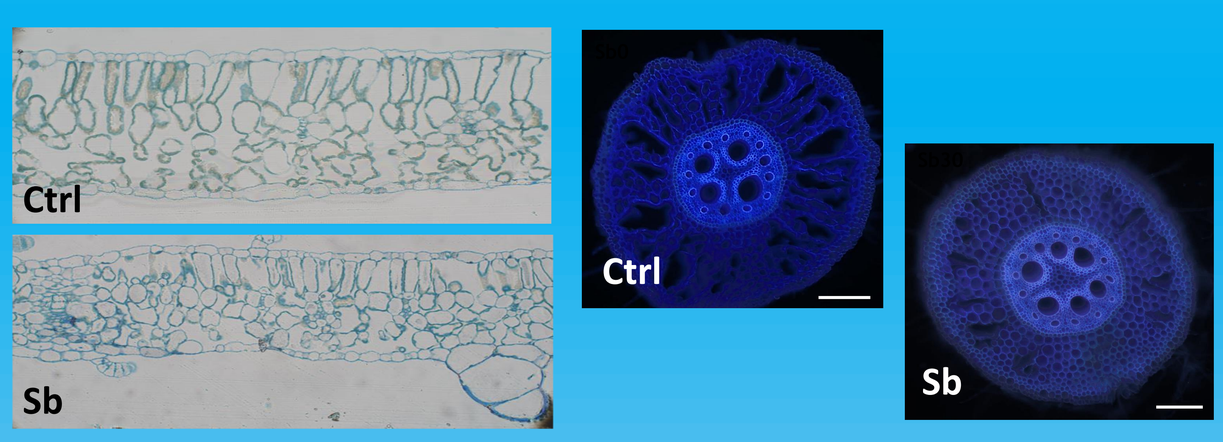
Occurrence of periderm in monocots is quite unusual. However, in roots of *Merwilla plumbea*, a south African monocotyledonous medicinal plant, hypodermal periderm layers (marked with an asterisks on Fig. E and F) were formed as a reaction to cadmium.

(Lux et al., 2012, Ann Bot 107, 285 – 292.)



As a response of copper, a unique root structure called „subero-lignified apical deposit (SLAD)“ has been discovered. SLAD consists of modified cell walls of central cylinder and endodermis, and is coupled with xylem differentiation and root branching close to the root apex. SLAD is probably a part of stress induced responses which relates to decreased root growth or permeability in heavy metals stress.

(Kováč et al., 2018, Ann Bot 122, 823 – 831)

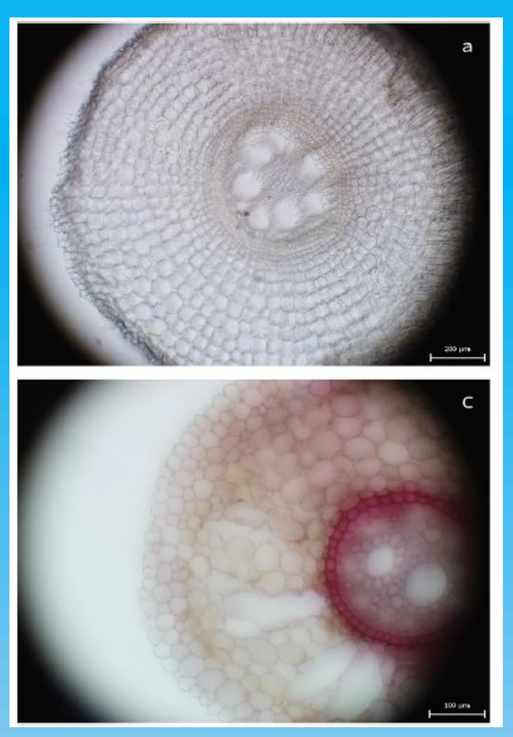


Antimony has been shown to reduce the intercellular spaces in sunflower leaves. Similar effect of Sb has been observed in maize where it reduces the size of root aerenchyma.

(Vaculík et al., 2015, Environ Sci Pollut Res 22, 18699 – 18706
&
Vaculíková et al., 2016, Environ Exp Bot 128, 11 – 17)

Deposition of lignin to the cell wall acts as additional protective mechanisms against metal(loids). Compared to control root (upper fig.), the bottom figure shows the massive deposition of lignin to endodermal cell walls in roots of *Arundo donax* after arsenic exposure.

(Shetty et al., 2012, Environ Sci Pollut Res 28, 55476 – 55485)



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