Revealing the internal anatomical development of mangrove seedlings using Computed Tomography and microtomy

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During the development of most dicotyledonous seedlings to young trees, plants build a ring of vascular tissue consisting of vascular bundles. These bundles unite, forming a vascular cylinder that subsequently increases during radial growth. During this radial growth, the primary xylem and pith tissues inside the vascular cylinder remain structurally unchanged, while the tissues outside the cylinder are forced outward (Eames & MacDaniels, 1947). As a result, the tissue proportions within the stem of young woody plants change over time. Young plants of viviparous Rhizophoraceae mangrove species start their development from fruit to seedling when still attached to the parent tree (Tomlinson, 1994). These mangrove seedlings have a thick, elongated hypocotyl containing cortex and pith tissues that allow them to cope with tidal inundations (Youssef & Saenger, 1996; Kathiresan & Bingham, 2001). To better understand the ecological and biogeographical success of mangrove trees, more thorough knowledge is required on the early development of mangrove seedlings. We aimed at studying the hypocotyl tissue proportion changes (i) during development over time and (ii) with hypocotyl height in seedlings of *Bruguiera gymnorrhiza* and *Ceriops tagal* using X-ray Computed Tomography (CT) and manual microsectioning. We observed that the vascular tissue proportionally increased over time in both species thereby changing the proportions of the other hypocotyl tissues (outer cortex, inner cortex and pith) but not in the same way for both species. In *B. gymnorrhiza*, the outer cortex increased and the inner cortex decreased over time at hypocotyl mid-height, while the opposite was observed for *C. tagal*. The proportions of the different tissues also changed with hypocotyl height: a clear decreasing trend in the inner cortex and increasing trend in the vascular tissue with hypocotyl height was observed in both species. According to our results, *C. tagal* seedlings seem to depend more on storage tissues (*i.e.* inner cortex and pith) for their growth than *B. gymnorrhiza* seedlings. These observations show that *B. gymnorrhiza* and *C. tagal*, although from the same family and their seedlings being homologous structures, behave differently in terms of internal development related to their morphology and location in the mangrove zonation. *C. tagal* seedlings occur more landinward than *B. gymnorrhiza* seedlings and are therefore exposed to a wider range of salinities (Matthijs *et al.,* 1999; Robert *et al.,* 2009a; Robert *et al.*, 2009b), suggesting that *C. tagal* seedlings need their storage tissues to store more water enabling them to cope with salt- and drought stress. This shows that closely related species, thriving in the same habitat, may have different internal development strategies due to specific needs for survival. We also show that CT-scanning is a very useful non-destructive technique to obtain information about overall tissue development over time, when complemented with a selected number of manually made microsections.

References

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