Mangrove propagule size and oil contamination effects: does size matter?

Mangroves thrive in sheltered locations of intertidal zones of tropical and subtropical regions and are highly vulnerable to oil spills. Oil penetrates the soft mangrove sediments and coats aerial breathing roots. This leads to oxygen deficiency, suffocation, growth irregularities and eventually, mortality. In this study, we determined if species with larger propagules were more tolerant to oil pollution that those with smaller propagules. We therefore selected three species of mangroves with different propagule size: *Avicennia marina* (2.5 ± 0.3 cm), *Bruguiera gymnorrhiza* (16 ± 2 cm) and *Rhizophora mucronata* (36 ± 3 cm). Species with large propagule size (and greater maternal reserves) such as *R. mucronata* and *B. gymnorrhiza*, would be expected to be more tolerant of oil contamination than those with smaller propagules such as *A. marina*. These three species were subjected to various oiling treatments in a series of experiments in the field and in the glasshouse. Oil was applied to the soil, propagules, leaves and stems. Oiling reduced plant height, number of leaves and caused growth abnormalities (Fig. 1).

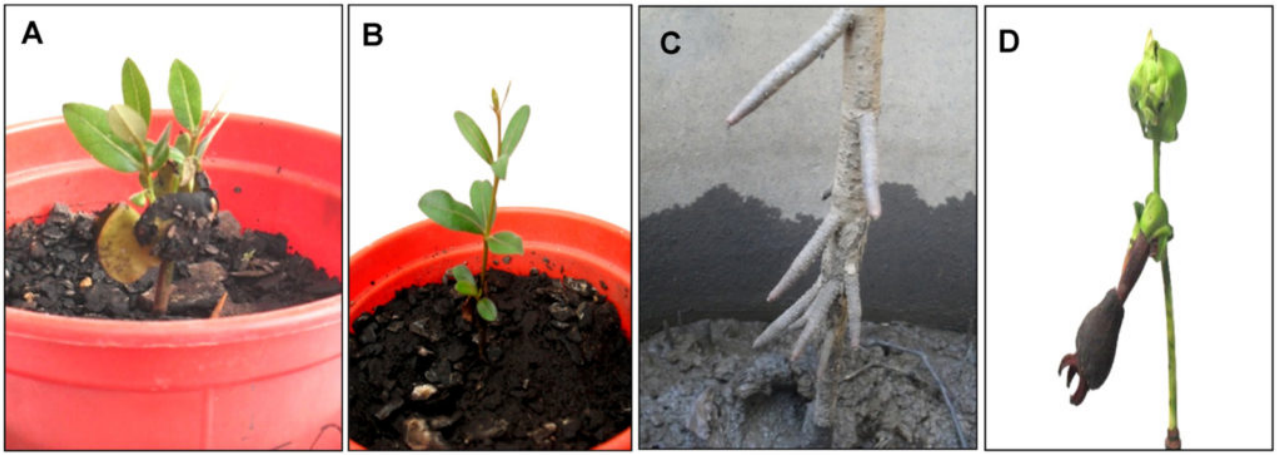

Fig. 1. Morphological abnormalities after oil contamination. (A) Abnormal shoot growth in oiled A. marina propagule after 12 weeks. Note two shoots growing from the propagule, a smaller third shoot is present but obscured. (B)Whorled leaf arrangement in oiled A. marina propagule after 8 weeks. (C) Adventitious root development in a sediment oiled A. marina plant in the field after 53 weeks. (D) Unfurled leaves and persistent leaf cap of R. mucronata in the propagule oiled treatments after 28 weeks.

Oil that penetrated the seedlings damaged chloroplasts and reduced chlorophyll content, photosynthesis and growth. Adverse growth effects were greatest in *A. marina*, intermediate in *R. mucronata* and least in *B. gymnorrhiza*. *Avicennia*, the species with the smallest propagule, was more susceptible to oil than *B. gymnorrhiza* and *R. mucronata*, which have larger propagules. Our

results showed that:

marina is a fast growing pioneer species which produces roots rapidly for anchorage and nutrient acquisition, which enables greater survival than those with larger propagules such as *Bruguiera* and *Rhizophora*.
Propagule development and establishment are more rapid in *marina,* (about one week) than in *B. gymnorrhiza* and *R. mucronata* (about six weeks). Oil therefore enters *A. marina* seedlings earlier than in slower growing species such as *B. gymnorrhiza* and *R. mucronata*. In *marina*, the seed coat which encloses the entire embryo, is discarded within a few hours, enhancing rapid seedling establishment. Loss of the protective coat exposes the entire seedling (cotyledons, hypocotyl and meristems), thus accounting for the greater susceptibility of this species to oil. Propagules of *B. gymnorrhiza* and *R. mucronata* do not shed an outer covering like *A. marina*, are bulky and covered with a waxy cuticle and suberized epidermal cells which minimize oil penetration.
Propagules of *mucronata* were more susceptible to oil than those of *B. gymnorrhiza* probably due to the presence of numerous breathing pores through which oil could enter. Propagules of *B. gymnorrhiza* lack breathing pores and have a thicker propagule covering than *R. mucronata*.

These data show that the period between dispersal and rooting is a critical life stage for propagules and varies among mangrove species. After seedling emergence in *A. marina*, other factors such as presence of leaf hairs (which traps oil), salt glands (through which oil enters) and lack of protective barriers in the roots contribute to greater oil susceptiblity. Species like *B. gymnorrhiza* and *R. mucronata* lack leaf hairs and salt glands and have thicker protective barriers in the propagules and roots to exclude oil entry.

This study clearly showed that the greater susceptibility of *A. marina* to oil is due to early shedding of the protective seed coat and rapid seedling development after detachment from the parent tree and not to propagule size. After germination, other factors such as presence of leaf hairs, salt glands and weaker barriers in the roots permit greater oil entry into *A. marina.*

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