THE EFFECT OF LUBRICATING OIL POLLUTION ON GROWTH AND PHYSIOLOGICAL RESPONSE OF MANGROVE

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The Effect of Lubricating Oil Pollution on Growth and Physiological Response of Mangrove

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by
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Declaration

The research described in this PhD thesis was conducted under the supervision of Professor N.F.Y. Tam at the Department of Biology and Chemistry, City University of Hong Kong. It was an independent work of the author unless otherwise stated and has not been included in any other thesis or dissertation submitted to this or other institution for a degree, diploma or any other qualifications. Attention is drawn to the fact that anyone without the author’s prior consent strictly may not copy, reproduce, transform, or publish any data derived form the author’s own work in this project.

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Abstract of Thesis Entitled

The Effect of Lubricating Oil Pollution on Growth and
Physiological Response of Mangrove

Submitted by Zhang Chunguang

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Abstract

The present study aims to investigate the effects of fresh and spent (used) lubricating oil on germination, early growth and physiological response of four mangrove species commonly found in Hong Kong, namely Kandelia candal, Bruguiera gymnorrhiza, Aegiceras corniculatum and Acanthus ilicifolius in sandy and muddy mangrove sediments. The response of these four mangrove species to different spent lubricating oil dosages, multiple small dosages and single large dosage were investigated. Both fresh and spent oil, at a single initial dosage of 5L m^{-2}, did not have any effect on germination (i.e. initial establishment) of B. gymnorrhiza and K. candal, the viviparous species with long slender propagules (the dropper with an average size of 15cm and 18cm long, respectively). All propagules were successfully developed into new seedlings within 30 days, same as the control (without any oil addition). On the contrary, oil-treated A. corniculatum (another viviparous species with an average dropper’s size of 5cm long)
and *A. ilicifolius* (a non-viviparous species with very small-sized seeds) were unable to germinate. Although germination of *B. gymnorrhiza* and *K. candal* were not affected, early growth, including height, leaf number and biomass of the oil-treated seedlings was significantly reduced; while content of free radicals and malonyldialdehyde (MDA), and activity of superoxide dismutase (an anti-oxidant enzyme) increased with oil treatment in both sandy and muddy mangrove sediments. These results indicate that lubricating oil acted as an oxidation stress, caused lipid membrane damages and growth reduction in young seedlings of *B. gymnorrhiza* and *K. candal*.

Among the four mangrove species studied in present study, the patterns of growth and physiological changes of the young seedlings to the addition of spent lubricating oil were similar, all showed growth reduction when compared to the control. However the sensitivity to oil toxicity varied among species, with *K. candel* being the most sensitive species, and its relative growth rate and biomass decreased more than the other three species. On the contrary, *B. gymnorrhiza* was the only species that could survive under the highest oil dosage treatment (15L m\(^{-2}\)) and was most tolerant to oil pollution. In terms of physiological response, the activities of superoxide dismutase increased significantly in leaves and roots of oil-treated seedling of all four mangrove species. The amount of superoxide radical release and malondialdehyde content of oil-treated seedlings also increased. The superoxide radical release, superoxide dismutase activity and malondialdehyde content of *K. candel* increased more than other species, further supporting that *K. candel* was the most sensitive species. Compare to a single oil dosage of 15L m\(^{-2}\), the multiple small dosages with repeated weekly addition of 1L m\(^{-2}\) for 16 week posed less negative effects on growth of mangrove plants.
The response of *B. gymnorrhiza* and *A. corniculatum* to spent lubricating oil under different environmental conditions were examined through a series of greenhouse experiments. The biomass of oil-treated *B. gymnorrhiza* and *A. corniculatum* under high salinity (35ppt) treatment was less than that of lower salinities (5ppt and 15ppt), indicating that high salinity enhanced the toxicity of spent lubricating oil on mangroves. The biomass reduction of oil-treated mangrove seedlings grown under long tidal regime (24hr/24hr high/low tide) was more severe than those under short tidal regime (12hr/12hr and 6hr/6hr high/low tide). The addition of nutrients at different amounts did not change the oil damaging effects on growth of both species. In terms of physiological response, higher salinity, longer tidal regime and nutrient addition caused more increases in the amounts of superoxide radical release and malondialdehyde, but there was no obvious difference in activity of superoxide dismutase among different treatments of salinity, tidal regime and nutrient additions.

The present study revealed that germination of mangrove propagules was related to the degree of oil coverage on the propagules, the whole submergence or coating by the oil would completely inhibit germination. Although mangrove seedlings could survival under low dosage of lubricating oil treatment, growth of mangrove seedlings was stunned with sub-lethal physiological damages. The results also indicated that the response of mangrove plants to oil toxicity were affected by environmental factors, and oil damages were found to be more severe in mangrove swamps with high salinity and long tidal regime.
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