ISSN 1880-7682
Volume 7, No. 5 **November 2009**

ISME/GLOMIS Electronic Journal

An electronic journal dedicated to enhance public awareness on the environmental importance of mangroves

Challenges of planting mangroves in Kiribati

The Republic of Kiribati is an island country of central Pacific with a land area of 720 km^2 (Ward & Metz, 2004). It consists of a chain of 33 small atolls with elevations ranging from sea level to about three metres. Because of their low elevation, atolls are vulnerable to storm surges, sea-level rise and coastal erosion. Conditions are extreme because of salt spray, low rainfall and absence of surface water. Mangrove forests are structurally poorer since they are rooted in shallow coral characterized by low fertility and poor freshwater retention. A field survey conducted on four atolls reported a total of 258 ha of mangroves. Species were *Rhizophora stylosa*, *Bruguiera gymnorhiza*, *Sonneratia alba* and *Lumnitzera littorea*. They ranged in size from shrubs to trees up to 20 m tall and were typically found along shorelines of sheltered lagoons where they form a narrow fringe.

With support from the Ministry of Environment, Land and Agriculture Development, and the Ministry of Education, Youth and Sports, the International Society for Mangrove Ecosystems (ISME) has implemented a mangrove plantation project in Tarawa, Kiribati since 2005 (Chan & Baba, 2009). Funded by Cosmo Oil Company Ltd. Japan, the objectives of the project are to establish coastal green belts especially along the banks of causeways using simple planting techniques, to create suitable grounds for fisheries resources, and to educate school children and youths on the importance of mangrove ecosystems. Propagules of *R. stylosa* were collected locally and planted in groups of three at close spacing of 0.5 x 0.5 m. Some 31,000 propagules have been planted in nine sites. As the substrate is mainly coral gravel, iron rods were used to dig planting holes. These planting programmes were participated by school children and youth groups (Fig. 1).

Fig. 1. A planting program involving local youth

In successful sites e.g. Ananau Causeway where 1,800 propagules of *R. stylosa* were planted, survival was 90% a year after planting and over 50% after 3 years (Suzuki *et al*., 2009). Height and diameter were 1.2 m and 1.8 cm after 3 years, respectively.

Establishment was successful for seedlings planted between mean water level (MWL) and mean high water level (MHWL). Below MWL, seedling survival was impeded due to prolonged submersion during high tide, barnacle infestation (Fig. 2) and seaweed entanglement. Above MHWL, seedlings withered away (Fig. 3) due to direct scorching by the sun and heat accumulated in the coarse coral gravel during mid-day (>40^{o}C). Resultant plantations are long narrow belts with 3 to 6 rows of seedlings (Fig. 4).

Fig. 2. Stems of seedlings infested by barnacles

Fig. 3. Dead seedlings above the mean high water level in the foreground

Fig. 4. A long narrow belt with five rows of group planted seedlings

In unsuccessful sites e.g. Bonriki and Nanikai where 6,050 and 5,340 propagules were planted, respectively, mortality was almost 100% after 1.5 years (Suzuki *et al*., 2009). Growth of surviving seedlings was very poor.

Beside problems associated with poor soil nutrient, lack of freshwater, barnacle infestation and seaweed entanglement, these low-lying sites experienced an additional adverse factor of poor drainage during the low tide. Stagnant water in the shallow puddles formed becomes so hot during the day (~40^{o}C) that planted *R. stylosa* seedlings were killed (Figs. 5 and 6), similar to the cooking effect of hot springs.

Fig. 5. Seedlings are dying or dead due to a combination of adverse factors including stagnant puddles of hot water during the day

Fig. 5. Propagules planted in sites with stagnant puddles of hot water during the day

Acknowledgements

The authors are thankful to Cosmo Oil Company Ltd. Japan, for funding this project since 2005. Support from the Ministry of Environment, Land and Agriculture Development, and the Ministry of Education, Youth and Sports of Kiribati is gratefully acknowledged.

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