Propagation of Mangroves by Air-layering

by

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INTRODUCTION

The biological and geological importance of mangroves in coastal environs is well recognized. These halophytes contribute leaf-fall to marine food-webs, act as sediment stabilizers, and serve as a habitat for quite numerous organisms (Odum, 1971; Carlton, 1974; Walsh, 1974). They are consequently of considerable ecological and environmental significance. Attempts to revegetate coastal areas that have become denuded of valuable mangrove cover are also important environmentally and have involved two approaches: planting propagules (seedlings) or transplanting older, established plants (Teas, 1977).

Florida has three mangrove species: *Rhizophora mangle* L. (Red Mangrove), *Avicennia germinans* (L.) L. (Black Mangrove), and *Laguncularia racemosa* Gaertn. fil. (White Mangrove). *Rhizophora* seeds germinate on the parent tree and produce pencil-shaped radicles. These propagules break loose from the fruit, drop, and take root—or float off with the tide and become established elsewhere. *Avicennia* produces lima-bean-shaped fruits and the developing seedling remains inside until the fruit reaches the substrate. The pear-shaped fruits of *Laguncularia* also fall from the parent tree before producing roots.

Rhizophora propagules have been planted in Florida at Tampa Bay (Autry *et al.*, 1973), Sarasota Bay (Savage, 1972), Charlotte Harbor (Teas *et al.*, 1975), and Dry Tortugas (Davis, 1940). Plantings have been placed behind rubble or other protective structures to prevent waves from washing out seedlings. Transplanting of established plants (0.8–1.5 m high) has also been successful, yielding more than 90% survival and growth (Gill, 1971; Pulver, 1976), but both methods 'have problems'. Most reports indicate high seedling-loss even though the plantings are surrounded by a protective structure; it takes from two to four years for surviving propagules to establish themselves. Removing mangroves from a stocking area may damage the remaining stock by extensive disturbance. Costs for both techniques may also be prohibitive.

A third technique, air-layering, has been successfully attempted on St Jean Key, Pinellas County, Florida. Air-layering is a commonly-used horticultural technique (Hartman & Kester, 1975) in which short sections of bark and phloem are stripped to the cambium, the exposed area being wrapped with Sphagnum moss and aluminium foil to retain moisture. Rootings from air-layering are of moderate size, with developed wood, leaves, and branches. Layers (shoots) may be removed from parent plants and planted, eliminating the two–four years necessary for propagules to reach a similar size. Pulver (1976) briefly summarized limited air-layering attempts, with success only in *Laguncularia*, and suggested that this technique be pursued, as it would greatly reduce or eliminate damage to mangrove communities because it is unnecessary to remove stock plants in its operation. Recent studies (Woodruff, 1970; Rehm, 1976) have shown that a number of insect and crustacean pests are responsible for widespread damage to prop-roots, radicles, and seedlings. Air-layers bypass these problems initially, although adult plants may become infested eventually. This paper reports further results of root production by air-layering in Florida mangroves.

MATERIALS AND METHODS

Rhizophora mangle, *Avicennia germinans*, and *Laguncularia racemosa*, of various heights, were selected along State Road 693 on St Jean Key, Fort DeSoto County Park, Pinellas County, Florida, during April 1977. A girdling apparatus, designed to cut through the branch to the cambium layer, was constructed to maintain uniformity of girdles. Gill & Tomlinson (1971) reported no regrowth of *R. mangle* branches greater than 2.5 cm in diameter. Based on these data, we used branches of less than 2.5 cm diameter. Because of the ease of bark and cambium removal,

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Laguncularia racemosa was the most suitable for girdling, followed by *R. mangle* and *A. germinans*.

Layers were placed internodally if possible; however, some may have included adjacent nodes if internode length was less than the width of the girdling apparatus. Sphagnum moss was soaked in distilled water and applied to branches to surround the cut. Aluminium foil, cut into squares of approximately 15 × 15 cm, was wrapped around the Sphagnum and tied at the ends with plastic stretch-tape (Fig. 1). Twenty-two *Laguncularia*, 19 *Avicennia*, and 18 *Rhizophora*, trees were air-layered (5 air-layers per tree). Layers were checked for signs of root growth, and for leaf and branch senescence, at intervals of 15–25 days.

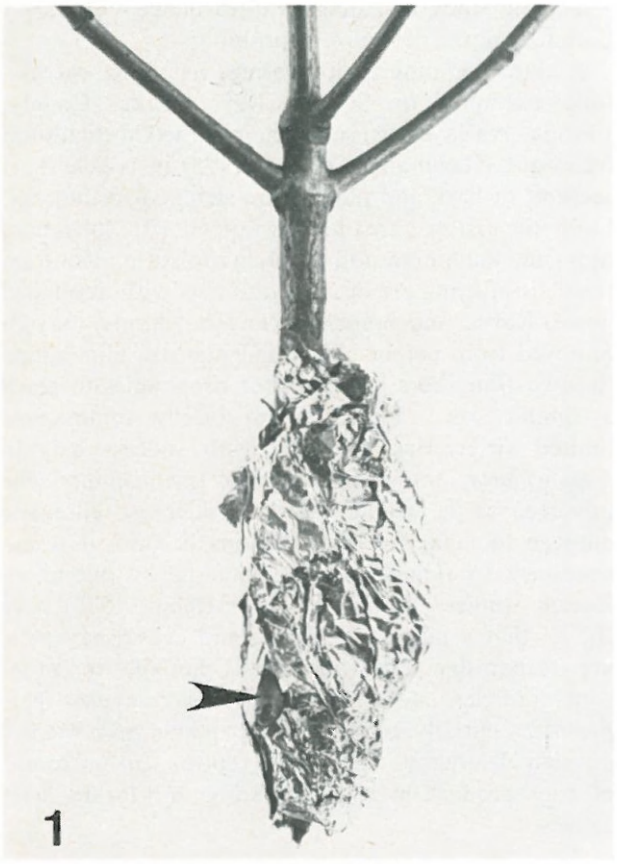

FIG. 1. *Mangrove air-layer* (Rhizophora mangle) *wrapped with aluminium foil. Arrow indicates protruding root* (ca $^1/_3$ *natural size*).

RESULTS

Root growth was observed from late September to early October, five to six months after the plants were layered. Not all experimental specimens had roots, but swelling on many unrooted branches indicated possible root initiation.

Rooting success was highest in *R. mangle* (39%), followed by *L. racemosa* (35%) and *A. germinans* (6%). *Rhizophora* roots were longest, often protruding through the aluminium foil (Fig. 1). *Avicennia germinans* and *L. racemosa* produced smaller roots, which occasionally filled the Sphagnum but did not project beyond the foil. Callus formation was observed in 45% of the *R. mangle* air-layers, 20% of *A. germinans*, and 15% of *L. racemosa*, which had not produced roots.

Rhizophora mangle roots appeared firm, with good colour, and often had short secondary roots extending from the main root (Fig. 2). Some *A. germinans* air-layers had clusters of roots coming off the stem at and above the layer site (Fig. 3). *Laguncularia racemosa* produced several roots and numerous rootlets along much of its length (Fig. 4).

FIG. 2. Rhizophora mangle *primary roots and short secondary root* (*arrow*) (ca *natural size*).

DISCUSSION

Mangrove restoration attempts have historically relied upon the uncertain success of planting propagules or transplanting older specimens. Both of these procedures can be costly, time-consuming, and have undesirable side-effects on accessory vegetation. The

FIG. 3. Avicennia germinans *with root development* (ca *natural size*).

FIG. 4. Laguncularia racemosa *roots and rootlets* (ca *natural size*).

results reported by Pulver (1976), and our early findings, indicate that air-layering may be a possible solution to these problems.

Air-layering at the beginning of the rainy season in Florida (May–June) assures exposure to higher humidities and temperatures, and decreases loss of moisture from the Sphagnum. Moisture retention is very important, apparently being a limiting factor in rooting. Too much water, however, may lead to rotting (fungal/bacterial infection) of the wood and death of the branch beyond the wound.

The specific number of air-layers which a mangrove tree can maintain has not been determined. About thirty air-layers can be established in an hour, based on our experiences on St Jean Key. An air-layering (girdling) knife can be made for less than $2, or purchased for about $15. Estimated costs for materials and labour per 1,000 air-layers is approximately $150.

Little if any serious damage should occur to mangroves which remain after air-layers have been removed. Several studies indicate that pruning of branches is not detrimental to mangrove trees (Savage, 1972; Carlton, 1974; Pulver, 1976). Lateral buds that are present on the branches should expand and replace leaves and branches which are lost through air-layering.

Preliminary information obtained from this study warrants further experimentation with air-layering of mangroves. Variables such as type of wrapping material (aluminium foil *vs* plastic), addition of rooting hormones, and whether plants can be planted directly into the marine environment or need first to be stored under mist conditions, are but a few tests to evaluate the usefulness of this new approach.

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