

MANGROVE NURSERIES IN BANGLADESH

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International Society for Mangrove Ecosystems (ISME)

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ISME Mangrove Ecosystems Occasional Papers No. 1

**Mangrove Nurseries
in
Bangladesh**

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Introduction

With few exceptions, mangroves all over the world are found in the form of natural forest. The practice of afforestation or reforestation in the mangrove areas is of recent origin and limited to a few countries only. This being so, adequate information is not available on nursery raising and planting techniques for mangrove species.

Bangladesh initiated mangrove afforestation in 1966 and up to 1990 an area of 0.12 million hectares had been brought under plantations. Virtually, all the commercially important species available in the natural mangroves have been tried in the exposed coastal belt of Bangladesh. *Sonneratia apetala* and *Avicennia officinalis* showed the best performance and they constitute 90% of the plantations. With the maturation and stabilization of soil and the rise of forest floor, selection of new species became necessary for establishment of a second rotation crop. A trial with all the commercially important mangrove species is now being carried out.

Knowledge gained during the raising of experimental plantations and information gathered from afforestation activities form the basis of this paper. As *S. apetala* and *A. officinalis* are the principle planting species, more information on nursery technique on these species is available in comparison with other species dealt with in this paper. Though the paper has been prepared in the light of experience under Bangladesh conditions, it is believed that the paper may be useful in other countries to a certain extent.

Nursery Techniques

Nursery and planting techniques vary considerably among the species. The following techniques have been employed:

1. Direct sowing of seeds in the field by dibbling.
2. Directing sowing of pretreated seeds.
3. Collecting seedlings from the natural forests and planting in the afforestation areas.
4. Raising seedlings on nursery beds and out planting of the uprooted seedlings.
5. Raising seedlings in polybags and planting in the field.

Raising Seedlings in Nursery Beds

a) Site selection and preparation:

A nursery site is selected in an area inundated by spring tides round the year. The size of the nursery varies from 1-10 ha depending on seedling requirement. An embankment with earth is made around the nursery site to control tidal water. It is preferable to develop the nursery near the planting site.

The nursery site is first ploughed. All weeds, grasses, debris and other vegetation are removed. Beds of size 1.2 x 12 m are prepared. The beds are separated by 30 cm wide and 20 cm deep drains. Levelling of beds is very important because this will ensure uniform watering of the beds during high tides. Side drains with greater depth and width around the nursery are kept for drainage of water at low tide.

b) Seed sowing:

Seeds are sown by broadcasting or dibbling depending on species. Sowing is done immediately after the preparation of beds during the neap tides.

c) Nursing:

Weeding is regularly undertaken. Fertilizer and insecticide are given when necessary. If the beds with seedlings are not tidally inundated in dry season, irrigation is made by a pump.

d) Uprooting of Seedlings:

Seedlings are uprooted when the beds are saturated with water to minimise damage to root systems. However, the root systems become highly developed and parts of the lateral and tap roots remained buried in the beds during uprooting. The uprooted seedlings are packed and transferred to the planting sites.

Raising seedlings (10 cm apart) on nursery bed, and out planting those to the field with balls of earth, was tried with success. This technique is economical but only practicable if the distance between the nursery and the planting site is short.

Raising Seedling in Polybags

a) Site selection:

Water level varies considerably during dry season and monsoon. Nursery sites should be selected at places rarely inundated by tidal water and by the side of water channels to facilitate watering and easy transportation of the seedlings to the

afforestation sites. As the nursery site is on relatively raised land fencing of the nursery area is required to control the entrance of cattle. A shed should be constructed where soil preparation and earth filling of bags are undertaken.

b) Soil preparation:

Soil is collected from the raised areas, air-dried in winter and mixed with cowdung at ratio 5 : 1. Fertilizer (T.S.P.) is also added at the time of mixing and crushing of the soil. Clayey soil should be avoided and loamy soil is preferable.

c) Polybag filling:

Polybags of size 15 cm x 10 cm can be used. However, planting should be carried out 10 months after seed sowing. The roots of most of the seedlings enter into the nursery beds by penetrating the polybags. Accordingly, the nursery beds are covered with polythene sheets on which the polybags are arranged. Though transportation of smaller polybags to the planting site is easy and convenient, a bigger polybag of size 15 cm x 25 cm was found more suitable as seedlings can be kept for a longer time, and larger seedlings can be grown.

d) Nursery bed:

Beds of size 1.2 m x 12 m should be prepared. A passage of 0.5 m among the beds is maintained for watering and supervision of the seedlings. Edging of beds is made from bamboo or wooden planks. Polybags (15 cm x 25 cm), filled with earth, are placed side by side and one such bed can accommodate 1440 seedlings.

e) Seed sowing:

Thorough watering of polybags should be carried out before sowing. Usually one fruit/seed/propagule is sown per bag. Germination success of *Excoecaria agallocha* and *Lumnitzera racemosa* is lower and two or more seeds are sown per bag for raising these species. In such cases, one seedling is retained if more than one seed germinates. The fruits or seeds are sown with two thirds of their body embedded in the soil and one third of the hypocotyles of the propagules is embedded in the soil. Heavy rain sometimes causes movement of seeds downward, then fresh sowing with new seeds is necessary. Shade over the nursery bed is given at a height 1 m above the bed and is removed when the seedlings are six months old.

f) Nursing:

1. Regular watering is vital for survival and healthy growth of seedlings.

2. Weeding has to be done regularly.
3. Spraying insecticides may be required in some cases.
4. Bags are rearranged at 30 days interval to prevent development of roots outside the bags.

Nursery Technique for Different Species

a) Keora, *Sonneratia apetala* Buch. -Ham.:

(See Figure 1, 2 and 3)

Initially seeds of this species were collected from the natural Sundarbans mangroves. Now seeds are collected from the plantations. Trees above six years old produce sufficient seeds. The colour of fruits changes from light green to dark green with maturation. Ripe seeds are available from July to September. However, seeds are mainly collected in late August by climbing healthy trees.

A fruit of *S. apetala* (See plate 1) contains 25-125 seeds and one kilogram contains 140-150 fruits. The fruits are heaped for 20 days to allow rotting of fleshy mesocarp. They are then rubbed and washed in water to separate the seeds. One kilogram of green fruits produces about 8000 seeds.

Seeds are generally sown in nursery beds by broadcasting in neap tides during the late monsoon when salinity is low. The seeds should be thrown with some force so that they get embedded and stick to the ground. Though the seeds maintain their viability for about a month, it is better to broadcast the pre-treated seeds within 2-3 days of collection in order to ensure maximum germination. For a nursery bed (1.2 m x 12 m), 0.5 kg of seeds are sufficient. Germination is completed within a week and approximately 75% germination success is obtained.

One bed yields about 3000 useable seedlings which are adequate to raise a plantation over 0.4 hectare. Seedlings are uprooted from the beds and generally outplanted from the age of 5 months, but 6-8 months seedlings (height 40-50 cm) showed maximum survival (60-70%). Small seedlings or too large seedlings show a higher mortality rate after planting in the field.

Problems:

1. Uncertain heavy rainfall immediately after seed broadcasting causes nursery failure and in that event repeated sowings are necessary.
2. Birds are found to eat the seeds. So, they are discouraged by beating a drum.



Figure 1. (top). Fruits of *Sonneratia apetala* kept in a heap to allow rotting of seed cases.

Figure 2. (top right). Broadcasting of *Sonneratia apetala* seeds on nursery beds.

Figure 3. (bottom right). Six month old *Sonneratia apetala* plantation in Barisal coastal area.



3. Insects, *Streblote siva* (Lasiocampidae : Lepidoptera) sometimes cause heavy defoliation of the seedlings and use of insecticide to control the pest is necessary.
4. In the winter, the nursery site may be dry due to lack of tidal inundation, then irrigation may be required.

b) Choyla, *Sonneratia caseolaris* (L) Engler:
(See Plate 2)

A plantation with this species was raised on only a few sites, during the early phase of the planting programme. So, information in relation to seeds and nursery technique is meagre. Ripe fruits are found in October and November. They are collected by climbing the trees.

The species can be raised in nursery beds, similar to those used for raising seedling of *S. apetala*. The fruits are larger than *S. apetala* and one kilogram contains 10-12 fruits. A fruit contains 500-2500 seeds depending on fruit size. Pretreatment of fruits and method of seed sowing are similar to that of *S. apetala*. Germination is completed within a week of sowing, with a success of about 60 percent.

c) Bean, *Avicennia officinalis* L.: (See Plate 3)

Mature seeds of *A. officinalis* are available in August. The fruits are collected from water or the forest floor or by climbing the trees. Fruits are single-seeded and on average, one kilogram contains about 300 fruits. Germination starts within 3 days and almost 90% of the seeds germinate within 10 days when sown in a nursery bed or in polybags by dibbling. Pretreated fruits can also be used to decrease establishment time and ensure higher germination success. Such treatment involves placing the fruits in small nets and exposing them to daily tidal inundation for about 5-6 days.

Fruits are directly planted by dibbling gently into soft soil. Dibbling is usually undertaken during neap tide to allow the seedlings to develop roots. Recently 1-2 months old seedlings, raised in a nursery bed and gently pulled out, have been out planted to afforestation sites. It has been observed that 10 months old seedlings (height 70-90 cm) raised in

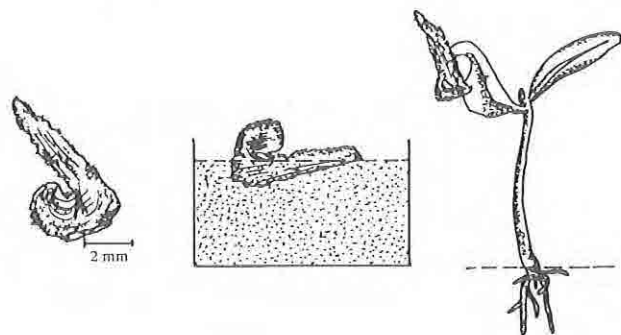


Plate 1 Seed, method of sowing and germinating seedlings of *Sonneratia apetala*

nursery beds show good survival rates. When seedlings are raised in polybags and out planted at the age of 10 months, a survival of 95% has been obtained. Planting is likely to ensure more successful plantations than sowing.

d) Sada baen, *Avicennia alba* Bl.:

The fruits are single seeded and one kilogram contains about 300 seeds. Seed collecting time is in August during the mid-monsoon period. Like *A. officinalis*, this species is raised by dibbling seeds into the soil. Seedlings, raised in nursery bed or polybag, can also be out planted into the field with good success.

e) Moricha baen, *Avicennia marina* (Forsk.) Vierh.:

Seed collecting time and method of raising nursery is similar to that of *A. officinalis*.

f) Gewa, *Excoecaria agallocha* L. : (See Plate 4)

Seeds of *E. agallocha* ripen between late July and early August. Seeds are collected from the forest

floor. Fruits are 2-3 seeded and one kilogram of green fruits contain about 2500 seeds.

Usually one year old seedlings are collected from the natural forest, packed and rapidly transported to the planting sites for out planting. Success with this method is quite satisfactory in natural forests when supplementing regeneration. However, in afforestation areas along the coastal belt this technique is not successful. For experimental planting, *E. agallocha* seedlings can be raised in polybags. It takes 3 weeks for completion of germination with 75% success. About 10 months old seedlings (height ranging from 40-70 cm) are planted. More than 95% survival has been obtained with this method.

g) Sundri, *Heritiera fomes* Buch. -Ham.:
(See Plate 5)

Fruit shedding of *H. fomes* takes place in June and July. Mature fruits are brown in colour but turns to dark brown as soon as the fruits come in contact with water. They are collected from the

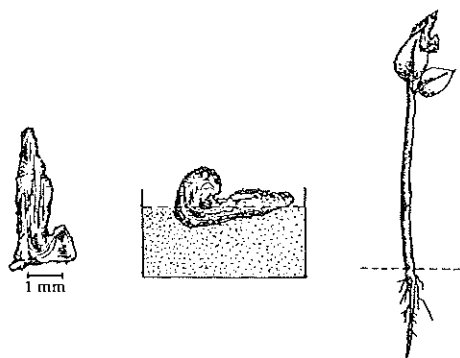


Plate 2 Seed, method of sowing and germinating seedlings of *Sonneratia caseolaris*

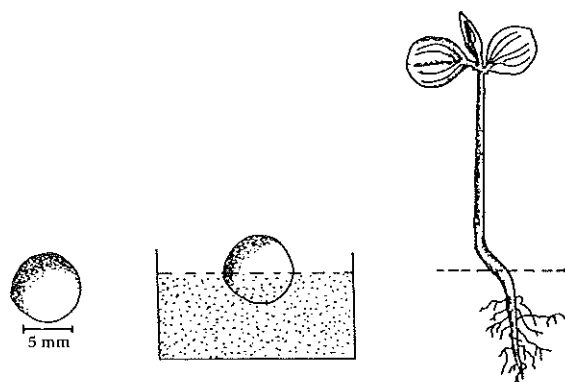


Plate 4 Seeds, method of sowing and germinating seedlings of *Excoecaria agallocha*

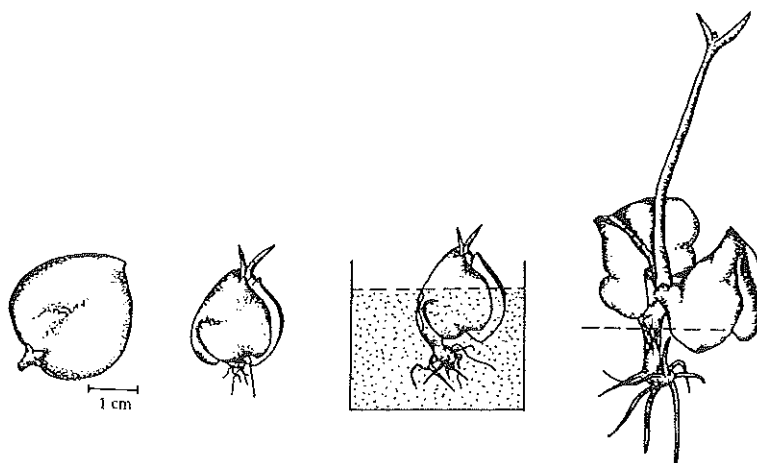


Plate 3 Seeds, pretreated seed, method of sowing and germinating seedlings of *Avicennia officinalis*

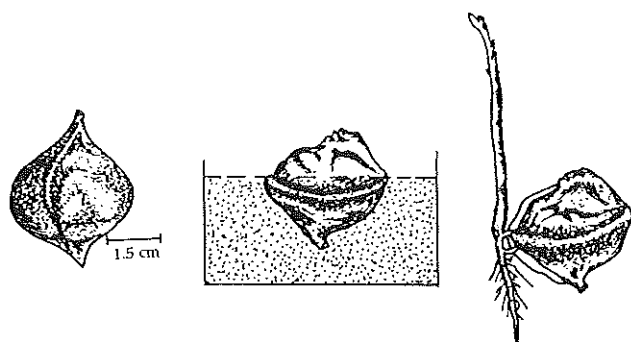


Plate 5 Seeds, method of sowing and germinating seedling of *Heritiera fomes*

forest floor. Fruits are single-seeded and one kilogram contains 75-100 fruits. To raise a plantation of *H. fomes*, dibbling the seeds was tried but with poor results, whereas, almost 90% of the seedlings survived when ten months old seedlings raised in polybags were planted. Average germination percent for the seeds of *H. fomes* was 75% and the germination is completed within a month when sown in polybags. Seeds may be stored for 30 days with 60% viability. In ten months, seedlings attained a height of 50-60 cm.

h) Passur, *Xylocarpus mekongensis* Pierre:
(See Plate 6)

The seed dropping occurs in June-July. Seeds were collected from the forest floor. Usually, a fruit contains 8-10 seeds and 75-125 seeds weigh one kilogram. Germination commences two weeks after sowing and continues for up to 12 weeks when seeds are sown in polybags. A germination of 75% is normally obtained. The seedlings attained a height of about 70-90 cm in 10 months. Almost 90% survival was found when seedlings, raised in polybags, were outplanted in the field on an experimental basis. Seedlings (2-3 months), collected from the forest floor, when planted in the field showed a survival rate of 10-20%.

The species though commercially very important has not yet been chosen for large scale planting because of its unsuitability on newly accreted land. Accordingly, it is not been resolved whether *Xylocarpus mekongensis* can be raised in a nursery bed and subsequently outplanted to establish plantations on a large scale.

i) Dhundul, *Xylocarpus granatum* Koenig:
(See Plate 7)

Ripe fruits are found in June-July during the early monsoon. Change of colour from light brown

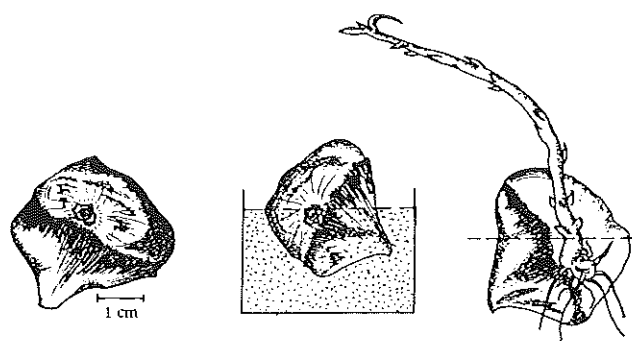


Plate 6 Seeds, method of sowing and germinating seedling of *Xylocarpus mekongensis*

to dark brown indicates the maturation of fruits. Fruits are collected by climbing the trees.

The fruits are large in size and the weight of a fruit may be up to 6 kilograms. Average weight of a fruit is 2.5-3 kg. A fruit may contain 5-15 seeds. The size of the seeds varies considerably and 1 kilogram contains 5-8 seeds.

Germination initiates 3 weeks after sowing and continues up to 12 weeks. A germination success rate of 60-65% is obtained when seeds are sown in polybags. Sometimes, the seeds are found to be attacked by the insects during the germinating stage and care should be taken. Ten months old seedlings raised in polybags (height 80-120 cm), when planted in an under-planting trial, had a 90% survival rate.

j) Shingra, *Cynometra ramiflora* L.: (See Plate 8)

The fruits ripen in June-July. Fruits are collected by climbing or from the forest floor. Colour change from greenish to light brown indicates seed maturation. The fruit is single-seeded and 1 kilogram contains 150-170 fruits. Germination starts after a week and continues for up to 8 weeks. Usually, 80% germination is obtained when the seeds are sown in polybags. Seeds are susceptible to insect attack. So, care should be taken during germination. Ten months old seedlings attain a height of 35-45 cm. A survival rate of 70-90% was observed when these seedlings were planted in an under planting trial.

k) Khalshi, *Aegiceras corniculatum* (L.) Blanco:
(See Figure 4)

The fruits ripen in July-August and when ripe they become lightly pinkish. The fruits are single-seeded (see Plate 9) and collected by climbing the trees. One kilogram contains 1200-1500 fruits. Germination initiates within 3 weeks and continues for up to 7 weeks. About 100% germination success

is secured. A height of 30-40 cm was observed at 10 months after germination in polybags.

1) **Kirpa, *Lumnitzera racemosa* Willd.:**

(See Plate 10)

Fruits of *L. racemosa* ripen in August. Fruits are single-seeded and collected by climbing the trees. One kilogram contains 8000-10000 fruits. Germination initiates within a week after sowing and continues for up to 8 weeks. About 20% germination success was observed when seeds were sown in polybags. Ten month old seedlings attained a height of 20-30 cm. A survival rate of about 80% was observed when seedlings were planted.

m) **Golpata, *Nypa fruticans* Wurmb:** (See Figure 5)

Mature seeds of *N. fruticans* (See Plate 11) are found from February to April. A colour change from light brown to dark brown indicates their maturity. The seeds are collected by cutting the fruit bunch. A fruit bunch contains 50 to 120 seeds. One kilogram contains 10-12 seeds. The bunches are stored for 3 days and subsequently the seeds are detached from the stalk by gentle pressure.

Direct sowing of seeds to the plantation sites by the dibbling method seldom results in a successful plantation as seeds are generally buried under silt deposition or washed out by tidal current. Seedlings of *N. fruticans* can be raised in the nursery by two methods:

1. Seeds are sown by dibbling method on nursery beds 5 cm apart. The beds are watered regularly for two months. Afterwards the seedlings are uprooted and out planted to the plantation sites.

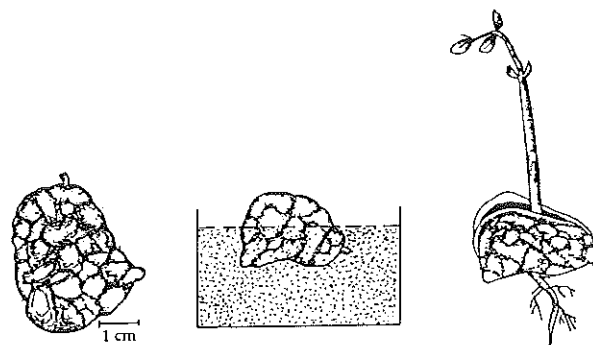


Plate 8 Seeds, method of sowing and germinating seedling of *Cynometra ramiflora*

2. The seeds are stored in a ditch periodically inundated by brackish water. The seedlings are transferred to the field when two months old.

A germination success rate of 90% is usually obtained. However, a common problem for both methods is the enormous development of a root system which prohibits storing seedlings in the nursery for a longer time. Recently, raising seedlings on beds underlaid by polythene sheet has been tried on an experimental basis. The seedlings attain a height of 80-90 cm in one year. More than 75% survival was achieved after planting these seedlings in the field.

n) **Hantal, *Phoenix paludosa* Roxb.:** (See Plate 12)

The seeds of *P. paludosa* ripen in July-August. A brown colour of the seeds indicates maturation. Seeds are collected by cutting the bunch. After storing the bunch for 2 to 3 days, the seeds are detached from the bunch. It takes about 4 to 5 days for decay of the mesocarp. The seeds are then washed and

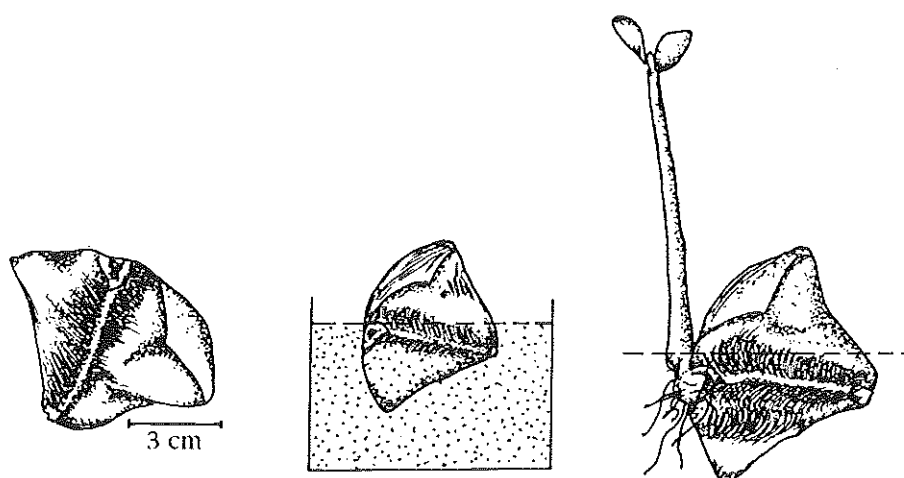


Plate 7 Seeds, method of sowing and germinating seedling of *Xylocarpus granatum*

sown in nursery beds or polybags by dibbling the seeds completely into the soil. One kilogram contains about 1200-1500 seeds. Germination starts from 10 weeks after sowing and continues for up to 20 weeks. A 80% germination success rate was obtained.

Up to now, a plantation with *P. paludosa* has not been established. For experimental purpose one year old seedlings, raised in polybags, were planted in the field and a survival of 100% was found.

o) Kankra, *Bruguiera sexangula* (L.) Lam: (See Plate 13)

Shedding of propagules occurs in June-July. The propagules are collected from the forest floor. The propagules are 8-15 cm long and 1 kilogram contains 70-80 propagules. When the propagules are planted in the polybags, almost 100% sprouting was observed within 5 weeks. Propagules are collected from the forest floor and directly planted in the Sundarbans natural forest and coastal afforestation areas. A survival success of 80% was obtained. No difference was found in respect of survival success from direct planting and planting 10 months old seedlings raised in polybags. It is, therefore, not desirable to raise the seedling in polybags. Seedlings attain a height of 25-40 cm in 10 months. A survival of 50-80% was observed when the seedlings were planted in the underplanting trial.

p) Goran, *Ceriops decandra* (Grift.) Ding Hou: (See Plate 14)

Shedding of the propagules occurs in June-July. The length of the propagules varies between 10 and 12 cm and 1 kilogram contains 200-250 propagules. About 95% sprouting of propagules is completed within 5 weeks when planted in polybags. The propagules grow up to 30 cm height in 10 months. A survival of 80-90% was obtained when these seed-



Figure 4. (top). Ten month old mangrove seedlings of different species in polybags.

Figure 5. (bottom). Seeds of *Nypa fruticans* being sown on a bed underlaid by polythene sheet.

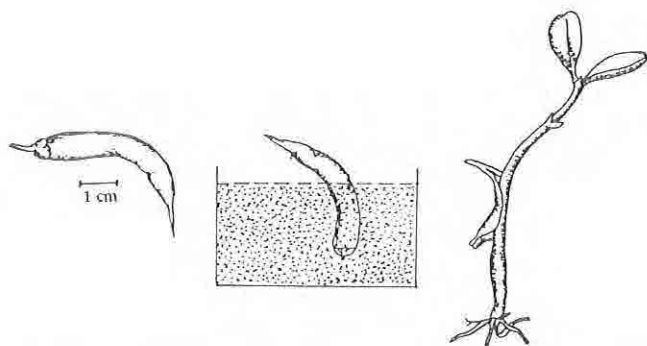


Plate 9 Seeds, method of sowing and germinating seedlings of *Aegiceras corniculatum*

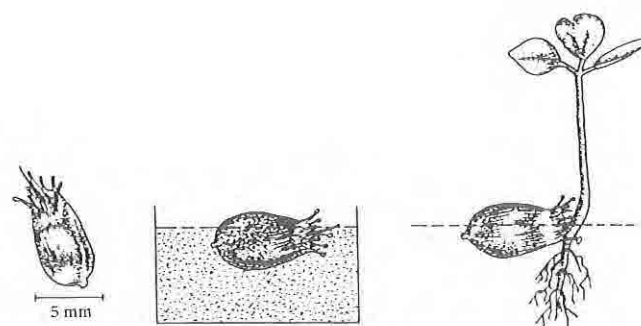


Plate 10 Seeds, method of sowing and germinating seedlings of *Lumnitzera racemosa*

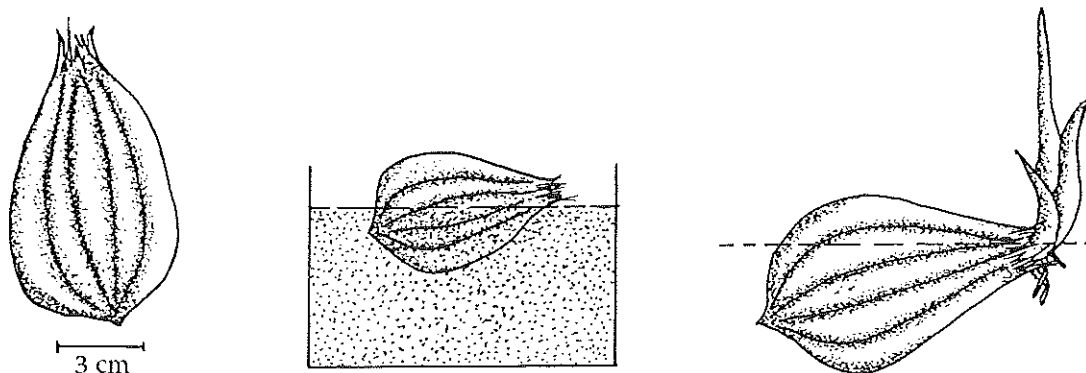


Plate 11 Seeds, method of sowing and germinating seedlings of *Nypa fruticans*

lings were outplanted in the field. Direct planting of propagules results in poor survival and therefore, it is preferable to plant seedlings raised in polybags.

q) **Gorjan, *Rhizophora mucronata* Lam.:**
(See Plate 15)

The shedding of propagules takes place in July-September. The length of the propagules varies from 40-60 cm and one kilogram contains 12-18 propagules. Sprouting starts within a week after planting in the polybags and almost 100% propagules sprout within 3 weeks. The propagules grow to a height of 100-125 cm in 10 months. Almost 100% survival was observed by planting the seedlings or by dibbling the propagules. It is, therefore, desirable to raise plantations by planting the propagules instead of raising them in a nursery.

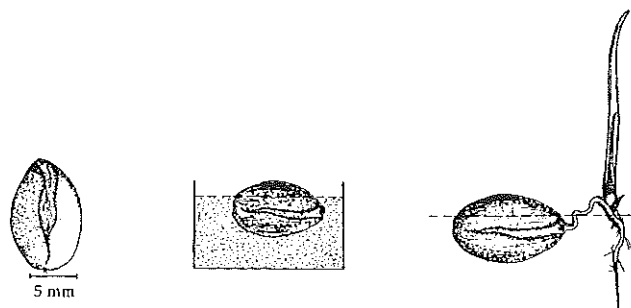


Plate 12 Seeds, method of sowing and germinating seedlings of *Phoenix paludosa*

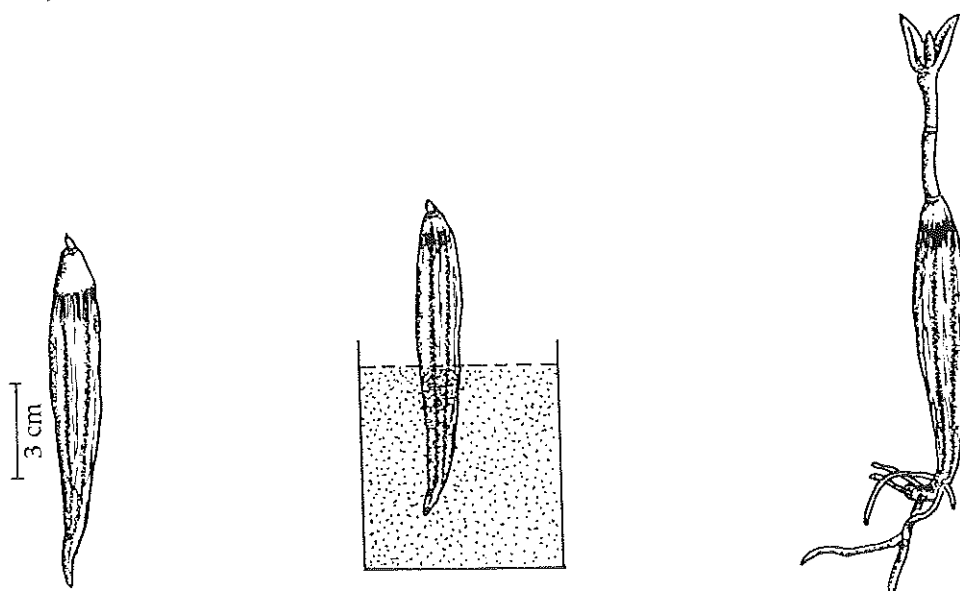


Plate 13 Seeds, method of sowing and germinating seedlings of *Bruguiera* sp.

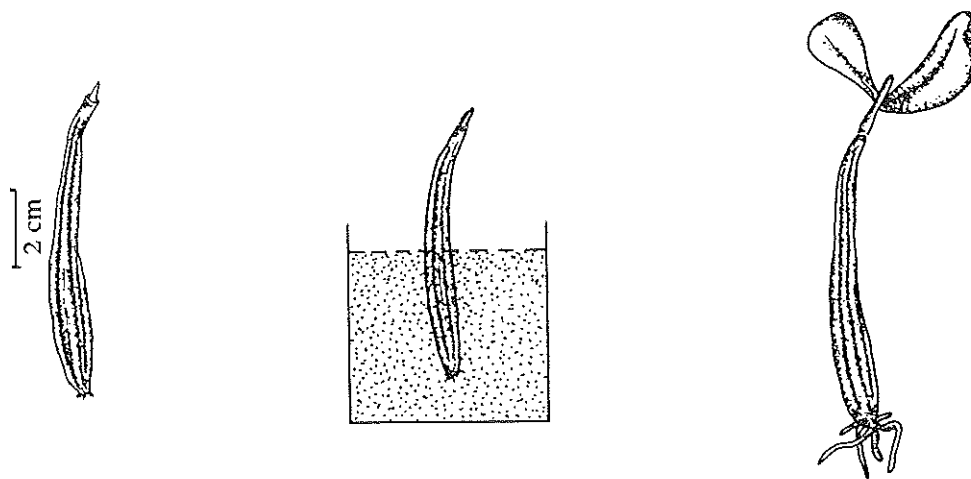


Plate 14 Seeds, method of sowing and germinating seedlings of *Ceriops decandra*

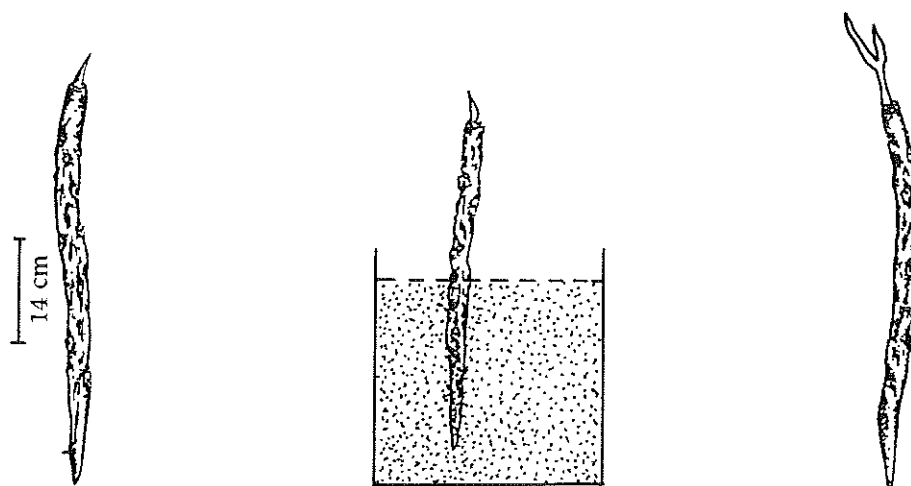


Plate 15 Seeds, method of sowing and germinating seedlings of *Rhizophora mucronata*

A summary of the planting data for the mangrove species considered is given in Table. 1.

Table 1: Seed collection time, material used, weight of seeds, viability, germination success and seedling growth of 17 mangrove species

| Name of species | Materials collected | Collecting time | Average no. of seeds per fruit | Average no. of seeds per kilogram | Sowing materials | Germination period | | | Germination success % | Storage time (days) with watering | Seedling height after 10 months (in cm.) |
|----------------------------------|---------------------|-----------------|--------------------------------|-----------------------------------|------------------|--------------------|-------------------|-------|-----------------------|-----------------------------------|--|
| | | | | | | Initiation (days) | Completion (days) | | | | |
| 1 <i>Sonneratia apetala</i> | Fruit | July-Sept | 50 | 22,000 | Seed | 4 | 7 | 75 | 30 | 80-100 | |
| 2 <i>S. caseolaris</i> | Fruit | October | 2,000 | 35,000 | Seed | 4 | 7 | 60 | 30 | 70-90 | |
| 3 <i>Avicennia officinalis</i> | Fruit | August | 1 | 300 | Fruit | 3 | 10 | 90 | 15 | 70-90 | |
| 4 <i>A. alba</i> | Fruit | July-Augt. | 1 | 300 | Fruit | 3 | 10 | 90 | 15 | 50-80 | |
| 5 <i>A. marina</i> | Fruit | July-Augt. | 1 | 300 | Fruit | 3 | 10 | 90 | 15 | 60-80 | |
| 6 <i>Excoecaria agallocha</i> | Seed | July-Augt. | 2-3 | 4,000 | Seed | 5 | 21 | 75 | 30 | 40-70 | |
| 7 <i>Heritiera fomes</i> | Fruit | June-July | 1 | 75-80 | Fruit | 8 | 48 | 85 | 40 | 50-60 | |
| 8 <i>Xylocarpus mekongensis</i> | Seed | June-July | 8-10 | 100-125 | Seed | 14 | 80 | 70 | 90 | 70-90 | |
| 9 <i>X. granatum</i> | Fruit | June-July | 5-15 | 5-8 | Seed | 20 | 90 | 60-65 | 60 | 80-120 | |
| 10 <i>Cynometra ramiflora</i> | Fruit/Pod | June-July | 1 | 160 | Pod | 7 | 60 | 80 | 60 | 35-45 | |
| 11 <i>Aegiceras corniculatum</i> | Fruit | July-Augt. | 1 | 800-1,000 | Fruit | 20 | 50 | 100 | 30 | 30-40 | |
| 12 <i>Lumnitzera racemosa</i> | Fruit | August | 1 | 9,000 | Fruit | 7 | 60 | 20 | 15 | 20-30 | |
| 13 <i>Nypa fruticans</i> | Fruit | Feb.-April | 1 | 10-12 | Fruit | 7 | 30 | 95 | 60 | 80-90 | |
| 14 <i>Phoenix paludosa</i> | Fruit | July-Augt. | 1 | 12,000-15,000 | Seed | 70 | 150 | 80 | 60 | 40-50 | |
| 15 <i>Bruguiera sexangula</i> | Propagules | June-July | 1 | 70-80 | Propagules | 10 | 40 | 100 | 30 | 25-30 | |
| 16 <i>Ceriops decandra</i> | Propagules | June-July | 1 | 150-200 | Propagules | 10 | 40 | 95 | 30 | 25-30 | |
| 17 <i>Rhizophora mucronata</i> | Propagules | July-Sept. | 1 | 12-15 | Propagules | 7 | 20 | 100 | 30 | 100-125 | |

Appendix

Nypa Nursery



Germinating seeds of *Nypa fruticans* seven days after collection. Photo: Khan, M. A. S.



Six months old seedlings of *Nypa fruticans* raised in beds underlaid by polythene sheet. Photo: Khan, M. A. S.

Nurseries for other species



Ten months old mangrove seedlings of different species in polybags.
Photo: Khan, M. A. S.



Three months old seedlings of *Avicennia officinalis* in nursery beds. Photo: Khan, M. A. S.

International Society for Mangrove Ecosystems

AIMS

To promote research and surveys and to associate with other organizations with the purpose of promoting the conservation, rational management, and sustainable utilization of mangroves; to serve as an intentional data-bank on mangrove ecosystems.

INVITATION

The mangroves are a major ecosystem of coastal

environments in the tropics. It is increasingly necessary to deepen our knowledge of mangroves. The study of mangrove ecosystems must include flora, fauna, microbes, soils, waters and their interaction. It must be looked at in the light of various disciplines, biology, botany, zoology, ecology, geography, oceanography and forestry.

Please join ISME and work with us within a framework of international cooperation to understand the world's mangroves.



APPLICATION FORM

Please fulfill this application form and return to ISME Secretariat.

1. Name in full (if applying for institutional membership, name of the representative)

First name _____ Middle name _____ Last name _____

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- ☐ Individual member: annual subscription ¥2,000, approximately U\$17, (or more)
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7. I (we) subscribe the amount of (¥/U\$) _____

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ACTIVITIES

- 1) To promote the study of mangrove ecosystems;
- 2) To promote the collection, evaluation and dissemination of information on mangrove ecosystems;
- 3) To promote mangrove ecosystem research, training and extension activities for sustainable management, rational utilization, rehabilitation and conservation of mangrove ecosystems;
- 4) To develop materials to enhance public awareness of the social, economic and ecological importance of mangrove ecosystems;
- 5) To organize and co-sponsor conferences, seminars, symposia and working group meetings; to organize lectures and courses; to publish both scientific and popular articles;
- 6) To support and implement research projects and programmes;
- 7) To promote the creation of a network of mangrove genetic resource centres;
- 8) To promote consultation and collaboration with other organizations (public and private) having related purposes;
- 9) Any other activities considered appropriate to further the objectives of the Society.

QUESTIONARY

1. State briefly your interest in world mangrove ecosystems. Ex: 1) Distribution; 2) Biodiversity of flora and fauna; 3) Species ecophysiology 4) Economic valuation; 5) Legislation and management; 6) others

2. State briefly your specialized field of research and geographic area of activity; Ex: 1) Chemical oceanography and coastal pollution; 2) Brackish waters aquaculture and fisheries; 3) Natural production 4) Soils and nutrient cycles; 5) Conservation and rehabilitation; 6) others

-Specialized field or research interest

-Geographic area and ecological field of activity

3. If you have any suggestions, opinions or request please write (include additional sheets if necessary).

ISME Secretariat
c/o College of Agric., Univ. of the Ryukyus
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MANGROVE ECOSYSTEMS PUBLICATIONS STOCKED

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1. Report:

- Nov. '86 Mangroves of Asia and the Pacific: Status and Management. Technical Report UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific (RAS/79/002) 538 pp.
- Nov. '87 Manual on Mangrove Palynology (Published jointly with the French Institute, Pondicherry)
- Sept. '88 Report on the Regional Symposium on New Perspectives in Research and Management of Mangrove Ecosystems, Colombo, Sri Lanka, November 11-14, 1986
- Sept. '89 Report on the Training Course on Life Histories of Mangrove Species, Bangkok, Thailand, October 2-16, 1985
- Nov. '89 Appendix to Report on the Training Course on Life Histories of Mangrove Species, Bangkok, Thailand, October 2-16, 1985
- Apr. '90 Manual for Investigation of Hydrological Processes in Mangrove Ecosystems, by B.Kjerfve, U.S.A.
- Jan. '90 Special Working Group Meeting for Planning the Pilot Research Programme of Phase Two, Ranong, Thailand, September 1-7, 1986

2. Mangrove Ecosystems Occasional Papers:

- No. 1 Jan. 1987 - Traditional Uses of the Mangrove Ecosystems in Malaysia - Chan, H. T. and Salleh Mohammad. Nor
- No. 2 May 1988 - Timber Volume Inventory, 1987 - Mohd. Jinnatul Islam and Faruq A. Khan
- No. 3 Sept. 1988 - Socio-economic Status of the Human Communities of Selected Mangrove Areas on the West Coast of Sri Lanka, 1987 - Amarasinghe, M. D.
- No. 4 June 1990 - Experimental Plantation for Rehabilitation of Mangrove Forests in Pakistan - Mohammad Tahir Qureshi - August 1986 - June 1988.
- No. 5 Nov. 1990 - Physiological Ecology of Selected Mangrove Crabs: Physiological Tolerance Limits - N. Paphavasit, S. Dechaprompun and E. Aumnuch
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- No. 9 Dec. 1990 - Timber Volume Inventory in the Sunderbans Using Aerial Photography and other Remote Sensing Techniques - Faruq Aziz Khan, A.M. Choudhury and Md. Jinnatul Islam

3. Project (RAS/86/120) Related Publication:

- M. Vannucci, 1989, The Mangroves and Us - A Synthesis of Insights, XVII + 203 pp. Published by Indian Association for the Advancement of Science, 55, Kaka Nagar, New Delhi - 110003, India.: Rs/ 150/-

Publications of ISME

ISME Mangrove Ecosystems Occasional Papers:

- No. 1 Mangrove Nurseries in Bangladesh - N.A. Siddiqi, M.R. Islam, M.A.S. Khan, M. Shahidullah

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