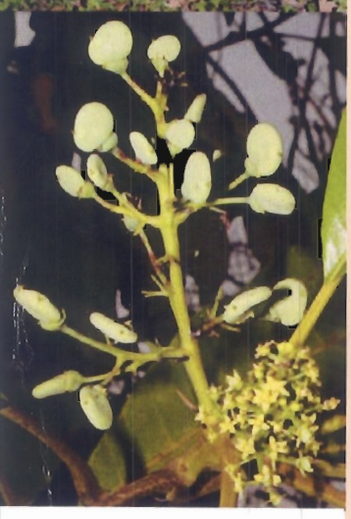

Species Recovery Plan for *Semecarpus Kathalekanensis*: a Critically Endangered Fresh-water Swamp Species of the Western Ghats

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EXECUTIVE SUMMARY

Species Recovery Plan for *Semecarpus kathalekanensis*: a Critically Endangered Fresh-water Swamp Species of the Western Ghats was taken up as subproject in the species recovery project.

For mapping of the swamps, a novel method using conventional survey and GPS readings were used and sixty individual *Myristica* swamps in Sirsi and Anchal mapped. *Semecarpus travancoricum* was located in Athirappally area, at slightly higher elevation of 300m . The same was located from Periyar and Parambikulam also. Using material obtained from Athirappally, vegetative propagation and germination trials were carried out. *Semecarpus anacardium* was located from Attappady area. *Semecarpus auriculata* was recorded from Kulathupuzha area.

Seedlings in polythene bags were quite hardy, with watering they could be kept in the nursery, there were hardly any insect or fungus attack. After replanting growth started once the roots were established. The plants needed watering in the dry months. There was hardly any insect attack on the plants, probably due do presence of resin in the plants. The plants showed rapid growth putting forth large leaves which eventually reduced weed growth (by blocking sunlight). Climbers if uncontrolled could cripple the seedlings. By three years the plants attained about 3m and three plants flowered in 2010. They were male flowers. Seven plants flowered in 2011and produced viable seeds, some of them germinated below the trees. Males:E3, F3, F4, G4. Females: G3, G5. E4. Few seeds germinated below the trees. A total of seven plants flowered in 2012. Males E3, F3, F4, G4. Females: G3, G5, E4. There were few seedlings below the trees in 2011. In 2012 as many as 10 seedlings could be counted below the trees, in the leaf litter.

Growth pattern of some of the associates were equally striking. *Myristica magnifica* planted in swampy area in arboretum produced stilt roots, gathered litter and widened the stream flow creating an original habitat like appearance. *Gymnocranthera farquhariana* was not surviving properly, but *Syzigium travancoricum*, an endangered tree, confined to the swamps were thriving well. *Holigarna gahammi* also showed surprising ability to grow fast and to occupy position above canopy.

Species Recovery Plan for *Semecarpus Kathalekanensis*: a Critically Endangered Fresh-water Swamp Species of the Western Ghats

(Section B Scientific and Technical Progress)

B1.1 Introduction

Species Recovery Plan for '*Semecarpus kathalekanensis*: a critically endangered fresh-water swamp species of the Western Ghats' was taken up as subproject in the species recovery project. A related species *Semecarpus travancoricum* is found in Kerala. These two species are very similar and are physically indistinguishable from one another. Various silvicultural parameters such as vegetative propagation, germination, growth and survival were recorded. Comparisons were made with local species. As part of the project seedlings from Sirsi forests supplied by the coordinator were planted in KFRI Peechi campus and field at Kulathupuzha. The results of planting trials, growth and other details are described.

B1.2 Objectives

The objectives of the KFRI component of the project were

1. Survey, raising nursery
2. Re-introduction, management.

B1.3 Materials and methods

Survey of Myristica swamps: The swamps could be mapped using latitude-longitude data collected using Global Positioning System (GPS) receivers. But this had severe limitation as dense canopy was limiting GPS usage. To overcome these difficulties, a novel method using conventional survey and GPS readings was devised. To start mapping, a location such as road junction is identified in the map and on the ground. GPS readings are recorded from this point to the boundary of the swamp and mapping continued along the boundary. When the GPS is not

able to provide values due to dense canopy overhead, distance and angle to the next point is measured using measuring tape and surveyor's compass. This is repeated till the GPS readings become available. Both these types of data are recorded in formats suitable for computer processing. In computer, a custom program converts angle – distance measurements to latitude-longitude values using the formula $x=d \cos \theta$ and $y=d \sin \theta$. *W*here **d** is the distance in meters and **θ** the angle (90- θ) from north. The output, the lat long values of locations along boundary in Mapinfo Import Format (MIF) can be overlaid over existing layers and plotted using Mapinfo program. For each boundary, few reference points are also collected and checked to ensure accuracy. Nearly all the swamps were mapped in this way.

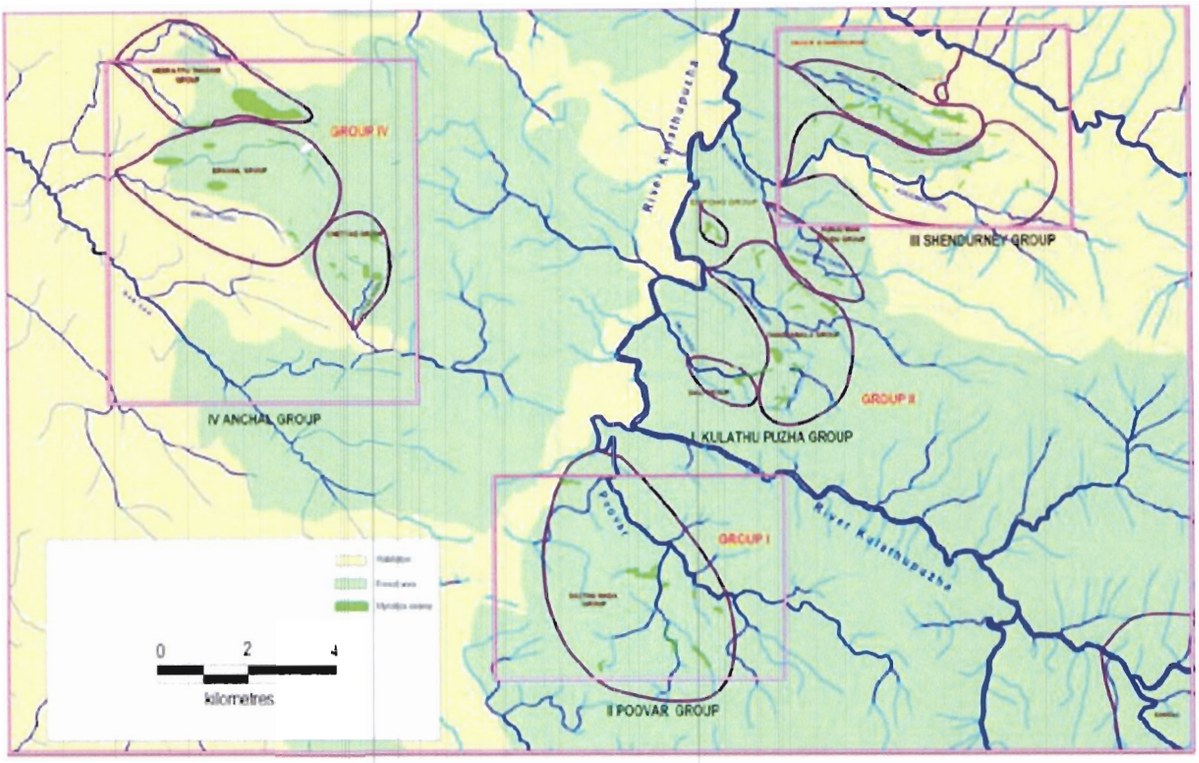
Raising nursery: Raising nursery involved germinating the seedlings, transferring to polybags, planting at the site, weeding, watering, protection, recording growth measurements and analyzing the data. For comparison same parameters for associate species found in the swamps were also carried out. Vegetative propagation was tried in a mist chamber. Germination trials were made in open and controlled conditions. Initially height of the saplings and later girth were recorded.

Re-introduction involved preparation of site and planting in pits at 2x2m spacing. One location was at Peechi campus of KFRI and another location at a degraded swamp in Kulathupuzha near Thiruvananthapuram.

B1.4 Results and discussions

The results are presented under three headings, survey of *Myrisitica* swamps, survey of *Semecarpus* members and planting trials

B1.3.1 Survey of *Myrisitica* swamps: Survey of *Myrisitica* swamps, initiated in a previous study was completed. A total of 60 swamps were surveyed. The swamps are shown in map. List of the swamps is given as an appendix.



Map of *Myristica* swamps in Kulathupuzha and Anchal

B1.3.2 Survey of *Semecarpus* members: A survey was carried out to locate species of *Semecarpus* found in Kerala. *Semecarpus travancoricum* was located in Athirappally area, at slightly higher elevation. The same was located from Periyar area. The species is reported from Parambikulam wildlife sanctuary also. From the Athirappally population vegetative propagation and germination trials were carried out. *Semecarpus anacardium* was located from Attappady area. *Semecarpus auriculata* was recorded from Kulathupuzha area, wildlings were planted in the KFRI arboretum as associate. Among the holigarnas, *Holigarna arnottiana* was recorded from Kulathupuzha, wildlings of which were planted as associate.

Holigarna grahami was also located from Kulathupuzha region and Athirappally region, seedlings were planted as associate. One individual of *Holigarna beddome*i was located from Kulathupuzha. *Gluta travancorica* was located from Kulathupuzha area. Other species of Aanacardiaceae are wild mango trees and domestic cashew nut trees.

It is clear that *Semecarpus travancoricum*, found in Kerala is slightly away from swamps. *Semecarpus kathalekanensis* found in Kathalakan regions is right inside the swamp. Elevation wise, both species are at about the same altitude. The swamps in southern Kerala are about 200m elevation. One could observe lattice of roots extending to water in Kathalekan swamps.

B1.3.3 Planting trials: *Semecarpus kathelekanensis* and allied swampy species were planted in KFRI campus and KFRI arboretum for growth studies. The swamp species includes *Semecarpus auriculata*, *Myristica fatua var.magnifica, Gymnacranthera farquhariana, Lophopetalum wightianum, Syzygium travancoricum, and Holigarna grahamii, etc*.

B1.3.3.1 *Semecarpus kathelekanensis*: Two hundred and sixty three (263) saplings of *Semecarpus kathalekanensis* were received from Sirsi. One hundred of these saplings were planted to KFRI arboretum on the seventeenth of October 2006. Other saplings were planted in suitable areas.

Seedlings of *Semecarpus kathelekanensis* obtained from Sirsi were planted in three sets. The first set consists of 100 seedling planted in 10x10 pattern with a spacing of 3 meters. Soil depth in the plot varied at locations.

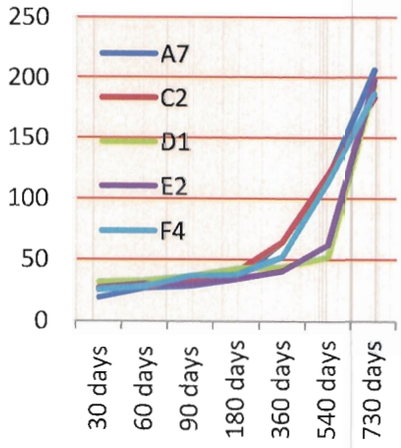
Growth pattern in Plot (10x10 pattern): In the 10x10 *Semecarpus kathelekanensis* plot, the central regions contains of outcrops of rock. Surrounding this, the soil is shallow. In the periphery of this is deep soil, details are shown in figure. The plot was located in the KFRI campus which facilitated continuous monitoring, weeding and watering in summer. Plants were watered from February May at two day intervals, without which initial survival is doubtful in Peechi climate.

The seedlings of about 25cm height were transplanted in October 2006. One month after wards 99% of the plants

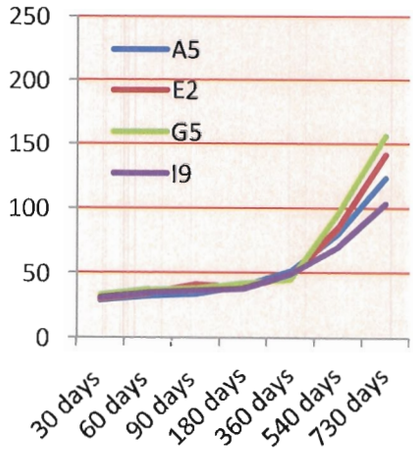
survived. Health of the plants were monitored qualitatively as poor, average and good. During the second month onwards healthy and weak plants could be distinguished. In the second month 70% seedling were showing good health. Six plants were of poor health. After six months, almost the same pattern continued, 8% of the plants, mostly belonging previously poor health started drying. Most of these plants were in areas with shallow soil. After one year 48% of the plants were healthy, 25% were average, 12 % poor and 15% had dried up. After this at one and half years and two years some of plants recouped and about 78 plants were of good health. Few more plants dried raising the value dried up to 22%. There was no more average or poor plants.

Examination of height of the plants after 2 years show that, deep soil is not the most preferred habitat locations adjacent to rocks is preferred. Some of the best plants are (A7 & C2, D1, E3, and F4). Some of the least growth showed plants are (G8, D2, D5, and D6). Medium growth showed plants are (A5, E2, G5, and I9).

Graph shows Growth Pattern of *Semecarpus Kathelekanensis*



Good Growth



Medium Growth

Major growth is after one year. This pattern is visible even in medium growth. But poor and dried plants failed to pick up the accelerated growth. Up to two years height was recorded, there after girth. The plants showed rapid growth putting forth large leaves which eventually reduced weed growth (by blocking sunlight). Climbers if uncontrolled could cripple the seedlings. By

three years the plants attained about 3 m and three plants flowered in 2010. They were male flowers. Seven plants flowered in 2011and produced viable seeds, some of them germinated below the trees. Males:E3, F4, F3, G4. Females: G3, G5. E4 No fruit setting but female. A total of seven plants flowered in 2012. Males E3, F3, F4, G4. Females: G3, G5, E4. There were few seedlings below the trees in 2011. In 2012 as many as 10 seedlings could be counted below the trees, in the leaf litter. After about 5 years several trees have girth in the range of 30-36 cm, height about 8m. *Semecarpus kathalekanensis* gave a few surprising results

1) Seedlings in polythene bags were quite hardy, with watering they could be kept in the nursery, there were hardly any insect or fungus attack.
2) After replanting growth started once the roots were established. The plants needed watering in the dry months. There was hardly any insect attack on the plants, probably due do presence of resin in the plants.
3) The plants showed rapid growth putting forth large leaves which eventually reduced weed growth (by blocking sunlight). Climbers if uncontrolled could cripple the seedlings.
4) By three years the plants attained about 3m and three plants flowered in 2010. They were male flowers.
5) Seven plants flowered in 2011and produced viable seeds, some of them germinated below the trees. Males:E3, F3, F4, G4. Females: G3, G5. E4. Few seeds germinated below the trees.
6) A total of seven plants flowered in 2012. Males E3, F3, F4, G4. Females: G3, G5, E4.
7) There were few seedlings below the trees in 2011. In 2012 as many as 10 seedlings could be counted below the trees, in the leaf litter.

***S. kathalekanensis* KFRI campus**

The plants after about one year of growth

The plants after about two years of growth

A branch with flowers and seeds

Close up of flowers

Close up of mature fruits

Growth pattern in KFRI Arboretum **:** A total of 10 plants were transplanted to KFRI arboretum in 23/03/2006, out of which 60% survived after two years and the plants reached maximum height up to 114 cm height, after two years (October-2008). These had no watering in summer months. The area was a moist valley and therefore the plants could survive. The trees survived but not as large as the trees in the plot.

Growth pattern in swamp**:** Seedlings planted inside swamp showed stunted growth and perished after few months, probably due to depleted nature of soil.

Other species: Seeds of *Myristica* species such as *Myristica magnifica* and *Gymnacranthera farquhariana* collected from Kulathupuzha forest and germination trials conducted in nursery and seed centre, obtained germination percentage was above 80%. Saplings of other RET species such as *Syzygium travancoricum*, *Myristica magnifica*, *Gymnacranthera farquhariana*, *Semecarpus auriculata*, etc, were collected from forest areas and are being maintained in KFRI arboretum and nursery for transplanting with Semecarpus kathalekanensis in selected forest areas.

B1.3.3.2 Germination trial of *Semecarpus kathalekanensis*

The seeds are collected from SIRSI (7/05/2008), a total of 57 seeds were used for germination, and the sand is the medium used for the germination (08/05/2005). Most of the seeds had germinated at the time of delivery; tips of some of the sprouts had dried. Total of 35 seeds germinated, that is 61% of total.

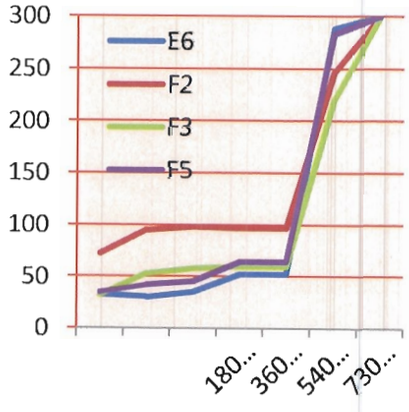
Germination trial of *Semecarpus travancoricum***:** Seed germination trials of *Semecarpus travancorica* was conducted in KFRI nursery. The seeds were collected from Sholayar forest area (15/02/2008), all the seeds were collected from the same tree. A total of 440 seeds were collected out of which 200 seeds were send to Sirsi for germination trials. A total of 240 seeds were used for germination trials in KFRI nursery (18/02/2008). Sand is the medium used for germination trials in KFRI nursery. Total of number 72 seeds germinated, that is 30% of

germination in which 27 seedlings dried immediately after the germination.

B1.3.3.3 *Semecarpus auriculata*

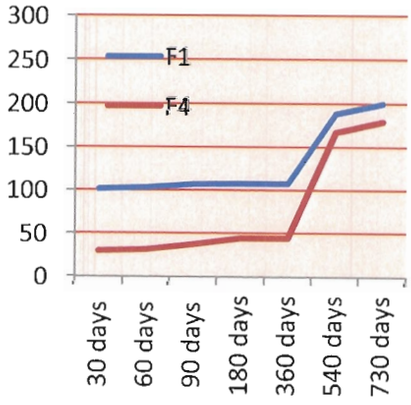
Semecarpus auriculata belongs to the same genera and are found in large numbers in swamps at Kulathupuzha. Seven wildlings were planted to compare the growth. Four plants showed good growth. Two of them were of medium growth, one dried up. In general plants were taller near shade. The plants seem to grow even without watering and are some what shade tolerant. Some plants have attained height above 10m but have not started flowering. In 2012 maximum girth recorded was 46 cm.

Semecarpus auriculata intialstage



Good Growth

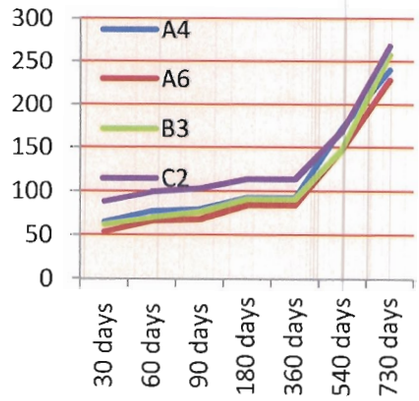
Semecarpus auriculata. After two years.



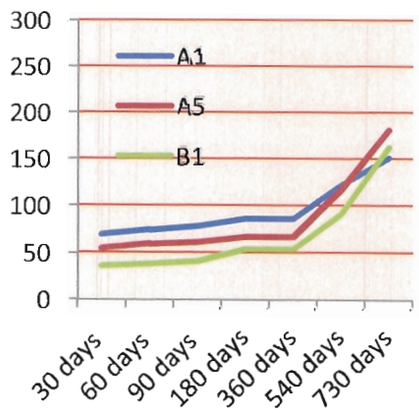
Medium Growth

B1.3.3.4. *Myristica fatua var.magnifica*

This is the predominant tree in Myristica swamps at Kulthupuzha. Seventeen seedlings were planted near the plot to compare growth and survival. These plants were watered in summer. Ten seedlings showed good growth after two years. One was of poor growth and one dried. Five plants were of medium growth. Growth pattern was similar to other swamp species. After one year the seedlings picked up rapid growth. The pattern was visible in plants of medium growth. After about two years, stilt roots started appearing in almost all saplings. Since these saplings were planted at a distance from the swamp, plants start wilting in dry season. This pspeceis is totally water dependant.



Good Growth



Medium Growth

A total of 15 plants were transplanted in the KFRI arboretum. These were in moist valley and were not watered. Out of the 15, 12 of them survived and attained height above 3meters. They also produced numerous stilt roots after one year. After four years the plants have grown almost into a typical *Myristica* swamp. After five years, the were producing more stilt roots and putting on girth. Height more than 5m and girth more than 20cm could be recorded. High ground was not really suited for this species as shown by their performance in the swampy area in the arboretum. In the swampy area the trees have attained more than 10m height and 30-33 cm girth. One interesting observation was addition of bigger stilt roots at higher heights which was creating evermore radius for the tree base. As a result of this leaves were getting trapped in the stream, soil accumulating over them and stream bed widening to about 2m from initial 0.5m.

Myristica magnifica in arboratum

Myristica magnifica in arboratum

Myristica magnifica in arboratum

Myristica magnifica in arboratum

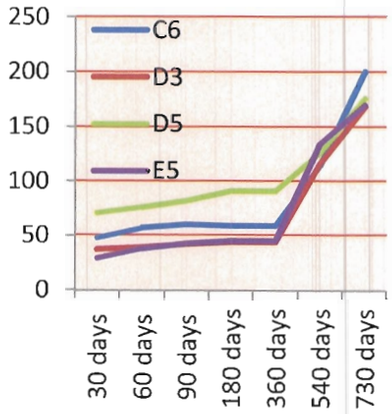
Myristica magnifica in arboratum

Myristica magnifica in arboratum

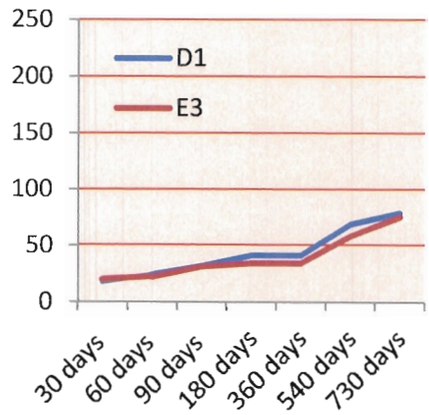
Myristica magnifica in arboratum. Stilt roots

B1.3.3.5 *Gymnacranthera farquhariana*

Gymnacranthera farquhariana, syn. Gymnacranthera canarica is the second most common tree in swamps in Kulathupuzha. A total of 12 seedlings were planted near the plot (C6, D1 to D6, E1 to E5). Four plants (C6, D3, D5 and E5) showed good growth, two were of medium growth (D4 and E2), two of poor growth (D1 and E3) and remaining dried up. Pattern similar to Semecarpus kathalekanensis was visible in G. *farquhariana* F. After one year the seedlings picked up rapid growth. The pattern was visible in plants medium growth. Even plants of poor growth maintained steady growth rate. Taller plants were in shaded areas. These wildlings planted in non moist areas and without irrigation showed poor growth.



Good growth



Poor growth

The saplings seem to grow rapidly from November to February. This could also be due to good rains during this period.

Arboretum: A total of 15 plants transplanted to KFRI arboretum out of which 6 of them survived and attained maximum height of 177 cm after two years, with numerous branches. This species also is totally dependant on water availability. Seedlings planted in the swampy part grow well, the ones drier regions show extremely stunted growth. Even in swampy areas no knee root has appeared even after four years. In general it appears to be a slow growing species

Gymnacranthera farquhariana

Gymnacranthera farquhariana

B1.3.3.6 *Lophopetalum wightianum*

A total of nine wildlings were transplanted in to KFRI arboretum in July 2007, these were collected from Kulathupuzha. After two year, 90% of them have survived and reached maximum height of 191cm. After four years, the plants have attained height above five meters. The specie is shade tolerant and not so much depended on water all the time. In spite of this it is found only in swampy areas in original habitat. After five years one tree attained a girth of 25cm.

Lophopetalum wightianum

Lophopetalum wightianum

Lophopetalum wightianum

Lophopetalum wightianum

B1.3.3.7. *Syzygium travancoricum*

In the case of the *Syzygium travancoricum* wildlings were collected from Kulathupuzha forest, out of which 10 of them were transplanted in the KFRI arboretum. Out of which 7 of them have survived. The plants attained height of above 3 meter. After four years the plants have attained height more than 7m. This species found in marshes seems to grow without inundation in the campus. In the wild, it is lofty tree and details of flowering can be attained only after considerable time. After five years, one attained a height of about 9m and girth 35cm. This was quite surprising for an endangered tree confined to the marshes.

Syzygium travancoricum

Syzygium travancoricum

Syzygium travancoricum

B1.3.3.8. *Holigarna grahamii*

Wildlings of *Holigarna grahamii* were collected from Kulthupuzha forest (June /2007) area and transplanted to the KFRI arboretum (Sep 2007). A total of 9 seedlings were planted in KFRI arboretum out of Which 6 of them survived and attained 80cm height within one year. After four years, four achieved height about 10m. Others are stunted. This species is not found in the swamps at Kulathupuzha. But it is found scattered in the forest in upper reaches. Saplings have a very high survival rate aslso.The rapid growth in the KFRI arboretum is particularly remarkable. It is highly pest resistant. It seems to overcome shade by growing rapidly upwards. After 5 years one of the trees has attained more than 10 m with a girth of 32cm.

Holigarna grahamii

Holigarna grahamii

B1.3.3.9. *Holigarna arnottiana*

Wildlings of *Holigarna arnottiana, a common tree was also planted in the arboretum.*

Holigarna arnottiana

ACKNOWLEDGEMENTS

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B2. Summary and Conclusions of the Progress made so far (minimum 100 words, maximum 200 words)

It could be established that *Semecarpus kathalekanensis* can be established in other areas successfully. Rare for a tree species, the introduced plants started flowering and produced seeds in about four years. On the fifth year, the seedlings were profusely germinating at the base of the trees. Watering in summer was required. Requirements of associated species of the swamps were slightly different; some needed full marshy conditions, while others needed watering in summer months.

B3. Details of New Leads Obtained, if any:

Successful species recovery was a remarkable feature for a tree species. Study shows that with detailed attention many sensitive plants could be re-introduced. The plants show maximum growth towards the end of the rainy season.

B4. Details of Publications & Patents, if any (Please enclose the reprint of publications (Also indicate Impact Factor)/ details of patent & IPR generated):

Publications are under npreparation, reporting the findings..

APPENDIX

Appendix I List of Swamps and area

Sl No.	Group	Group	Name Of Swamp	Area in Ha
1.	Ia 1	Poovar	Muppathadi	1.33
2.	Ia 2	Poovar	Pillekode	0.98
3.	Ia 3	Poovar	Kochamma	0.25
4.	Ia 4	Poovar	Chekidi Chal	3.61
5.	Ia 5	Poovar	Palli Thadam	3.24
6.	Ia 6	Poovar	Uthiran Chira	1.45
7.	Ia 7	Poovar	Karinkurinji Up	3.29
8.	Ia 8	Poovar	Karinkurinji Down	3.95
9.	Ia 9	Poovar	Sastha Nada	1.71
10.	Ia 10	Poovar	Ammayambalam	2.48
11.	IIa 1	Kulathu Puzha	Poovanathu Mood 0	3.24
12.	IIa 2	Kulathu Puzha	Poovanathu Mood 1	0.51
13.	IIa 3	Kulathu Puzha	Poovanathu Mood 2	0.29
14.	IIa 4	Kulathu Puzha	Poovanathu Mood 3	0.76
15.	IIa 5	Kulathu Puzha	Poovanathu Mood 4	1.22
16.	IIa 6	Kulathu Puzha	Chuvanna Karikkam	4.00
17.	IIa 7	Kulathu Puzha	Munnam Chal	10.00
18.	IIa 8	Kulathu Puzha	Plavu Chal	3.58
19.	IIa 9	Kulathu Puzha	Pullu Mala	1.50
20.	IIa 10	Kulathu Puzha	Perum Padappy	2.17
21.	IIa 11	Kulathu Puzha	Channa Mala - Up	0.31
22.	IIa 12	Kulathu Puzha	Channa Mala - Down	2.19
23.	IIb.1	Kulathu Puzha	Emponge	3.32
24.	IIc.1	Kulathu Puzha	Dali Karikkam	6.00
25.	IIc.2	Kulathu Puzha	Chithirakkala Pacha	4.00
26.	IId.1	Kulathu Puzha	Marappalam Minor	0.26
27.	IId.2	Kulathu Puzha	Mottal Mood	2.28
28.	IId.3	Kulathu Puzha	Marappalam Major	1.31
29.	IIe.1	Kulathu Puzha	Choondi Para	1.50
30.	IIe.2	Kulathu Puzha	Valavu Para Pacha	5.00
31.	IIe.3	Kulathu Puzha	Manjalu Para	3.00
32.	3a.1	Shendurney	Irrikappara	1.04

Sl No.	Group	Group	Name Of Swamp	Area in Ha
33.	3a.2	Shendurney	Kurunthotti Valavu	0.79
34.	3a.3	Shendurney	Kambakathottam	1.55
35.	3a.3	Shendurney	Choodal Se	1.77
36.	3a.4	Shendurney	Onnam Junda	1.39
37.	3a.5	Shendurney	Vilakku Maraum N	1.67
38.	3a.6	Shendurney	Vilakku Maraum S	0.71
39.	3a.7	Shendurney	Choodal S	0.53
40.	3b.1	Shendurney	Onnam Mile S	7.82
41.	3b.2	Shendurney	Munkuthu	12.50
42.	3b.3	Shendurney	Manchal	1.26
43.	3b.3	Shendurney	Kattilappara P	0.40
44.	3b.4	Shendurney	Kattilappara Se	0.22
45.	3b.5	Shendurney	Kattilappara S	2.32
46.	3b.6	Shendurney	Choodal E	2.90
47.	3c.1	Shendurney	Onammilen	0.48
48.	4a.1	Anchal	Ammbalathu Pacha(1&2)	1.75
49.	4a.2	Anchal	Chettadi(1&2)	5.00
50.	4a.3	Anchal	Anavettanchal	2.00
51.	4a.4	Anchal	Mottilam Pacha	1.00
52.	4b.1	Anchal	Kodukuthi Pacha	1.16
53.	4b.2	Anchal	Eravail Pacha	0.23
54.	4b.3	Anchal	Kalyani Up	0.66
55.	4b.4	Anchal	Kalyani Down	0.25
56.	4b.5	Anchal	Konju Kuzhi	1.12
57.	4b.7	Anchal	Kuravan Thery	2.00
58.	4b.8	Anchal	Mukkode	1.50
59.	4c.1	Anchal	Valiya Pacha	1.00
60.	4c.2	Anchal	Neerattu Thadam	16.00
			Total	**149.75**