INTRODUCTION
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Bamboos are one of the most important items of the forest product used by the rural communities in Asia and Pacific. It is reported that 75 genera and 1750 species of bamboo occur in the world (Soderstrom, 1985). About 300 species are so far reported from China, 136 species from India, 55 species from Philippines, 50 species from Thailand, 33 species from Bangladesh, 31 species from Indonesia, 26 species from Papua New Guinea and 12 species from Malaysia (Sharma, 1987). The largest forest area under bamboo is in India with 9.57 million hectors or 12.8% of total forest area.

In India 136 species comprising 21 genera are so far recorded. 32 species of 8 genera are known to occur in peninsular India, which include 8 species which are introduced and cultivated in this region (Kumar, 1990). The earliest descriptions of Indian Bamboo are found in Van Rheeds Hortus Malabaricus (1678-1693) in which three species were described: *Bambusa bambos, Ochlandra scriptoria* and *Ochlandra travancorica*. Beddome (1873) in his flora Sylvatica dealt with 18 South Indian bamboos. Gamble (1896) described 115 species from British India. Holtum (1958), Raizada and Chatterji (1963), Kumar (1990), Tewari (1992), Chand Basha and Kumar (1994) have made study regarding the reed bamboos.

Bamboos are belonging to the family *Poaceae*. The plant consists of
segmented vegetative axes, differentiated into rhizome, culm and culm branches. Each culm consists of a series of nodes and internodes with a sheath at each node. The subterranean rhizome may be pachymorph and sympodial in which the apex of rhizome grow upwards to form new culm. The rhizome continuously grow horizontally for an indefinite length and new culms are produced from the lateral buds. The young shoots which produce new culm are usually massive and solid, packed with food and are edible in some species. The nodes at the base of the culm are close together and produce adventitious roots. There is a strong cross wall at each node. The new culms grow slowly at first but growth soon increases rapidly to a maximum of about 30 cm per day. 75 cm per day has been recorded in giant bamboo in Ceylon (Purseglow, 1977). The thorns are produced at the nodes in certain species. The sheath which protects the culm gradually drops off when the growth is completed. These sheaths are the identification markers in Bamboo.

The culms usually reach its full height before branching. There is a lateral bud in the axil of each sheath. They grow out to produce primary, secondary and tertiary branches. The ultimate branch bear leaves.

The genus *Ochlandra* is endemic to South India (8 species and 1 variety). These group of bamboos are widely distributed in the forest of Kerala. There are 7 species and 1 variety belonging to this genus in Kerala. The widely distributed and common species which are found abundant are *O. travancorica,*
O. travancorica var hirsuta and O. scriptoria. O. travancorica species are more abundant in South Kerala especially in the forests of Thiruvananthapuram. O. travancorica var hirsuta was found in the forest areas of Thenmala, Ranni, Achencoil and Thiruvananthapuram (Muktesh Kumar, 1990).

Of all the reed species considered O. travancorica and O. travancorica var hirsuta are of high industrial value (Chand Basha, 1991).

The exact growing stock of reeds in the State has not been estimated. As per survey conducted in 1968 there were about 10,000 Km² of the reed forest with an annual availability of 5,00,000 tonnes of air dry reeds (Asari, 1978). In 1973 it was found that total area under reed forest was only 9,400 Km². Chandrasekharan (1973) estimated the reed areas as 185 Km² with a growing stock of 45,66,000 tonnes. The allowable annual cut was prescribed as 2.45% of growing stock i.e., 1,12,000 tonnes (air dry).

Asari (1978) conducted another survey and reed areas were reassessed as 869 Km². The survey made by Kerala News Print Factory (Asari 1977-78) revealed that 717 Km² falling under three categories has a scattered distribution of 351.45 Km², dense occurrence 325.875 Km² and pure reed areas 39.6 Km². The yield estimated was 18,000 tonnes (green) per annum as per previous survey. The Department of Forest assessed the availability of reeds in Kerala as 35,000 tonnes per annum (air dry).
Data collected by the Hidustan News Print Limited revealed that from 1970 to 1990 the total reed area lost permanently was 55 Km². About 50 Km² was found to be degraded due to poor regeneration as a result of gregarious flowering. The present total requirement for large scale industries is 274,000 tonnes while traditional sector under the Bamboo Corporation is 30,000 tonnes per year.

Utilization of reeds

Reeds are consumed by the two major sectors viz. (1) The traditional cottage industry sector and Modern industrial sector.

Traditional Sector

The State Planning Board identified this sector as traditional industry (Govt. of Kerala, 1973). Reeds are used for making a variety of products. The whole reeds are used for household purposes like reapers for huts, and cattle sheds, fencing making long brush handles, fishing rods, etc.

The majority of reeds are used for manufacturing baskets and mats. Bamboo mats are used for refining brown sugar into white sugar (Ajith Kumar, 1985). Mats are also used for making plywood.

The Kerala State Bamboo Corporation Limited (1969) came into action for the reed extraction field in order to free the traditional workers from the exploitative
hold of the merchants dealing with extraction and supply of reeds. They are now the major producers of Bambooply. Now the Bamboo emporium is facing the scarcity of reeds.

**Industrial sector**

Reeds are used as an industrial raw material for the manufacturing of pulp in Kerala from 1890 (Punalur Paper Mills). The requirement of reeds at that time was only 750 tonnes per year. The capacity of the industry was increased to 33,000 tonnes in 1972 and further 50,000 tonnes in 1975. The Hindustan News Print Limited utilises 189,000 tonnes reeds per annum.

**Factors causing reed forest degradation**

In past the pressure on reed forest was quite low. The tribals and other people depended on forest for their daily bread, constructing houses, making baskets or mats. Gradually more and more people utilised reed as raw material. The reed population in the forest area is diminished. The large scale application of reeds as raw material in paper pulp production, rayons, bambooply, handicrafts and mats decreased the reed forests. Labour intensive ventures like formation of commercial plantations of rubber, oil palm, cardamom required the clearance of large extent of fertile lands which invariably included good reed bearing areas. This process was irreversible and reed areas were permanently reduced.

Construction of hydro electric and irrigation projects destroyed the
most productive reed forests. Fire destroys the culms and burns the above ground portion completely.

The demand for the reeds are increasing day by day but the reed population is decreasing. Now a stage has reached for the large scale multiplication of the reeds. The seeds of the reeds have very low viability (Seethalakshmi 1993). Vegetative propagation of the reeds by culm cutting was standardized (Seethalakshmi et al 1990). This mode of propagation is also insufficient in meeting demands. In these respects to standardize an effective artificial regeneration technique for reed propagation was strongly recommended (Chand Bash, 1991).

Taking into consideration the importance of the State and the crop, the two economically important and vanishing group of reeds.

a) *Ochlandra travancorica*

b) *Ochlandra travancorica var hirsuta*

were selected for the present study.

a) *Ochlandra travancorica*

This plant is commonly known as 'Etta' or 'Eeral'. It is an erect shrubby or arborescent, gregarious bamboo. The culm is 2-6 m in height and greyish green in colour. The internodes are usually 45-60 cm long. The culm sheath is 15-20 cm in length, thin and longitudinally wrinkled.
Propagation

It is propagated mainly by the rhizome. Vegetative propagation through culm cutting was standardized by Seethalakshmi et al (1990). Seeds are also used for raising seedlings.

Anatomy

Histomorphological and Histo-chemical studies were carried out by Appasamy (1990). Anatomical features were studied with special reference to vascular bundle (Groser-D, 1971).

According to Thomas and Sujatha, (1992) O. travancorica is very efficient in soil conservation.

Uses - Raw material for paper pulp production, culms are used for mat and basket making, umbrella handles, fishing rods, handicrafts. Leaves are used for thatching. The mats are utilized for bamboo ply production.

(b) Ochlandra travancorica var hirsuta

The plant is erect shrubby, arborescent and gregarious in nature. The culm is usually 2-6 m tall grey-green, rough 2.5-5 cm diameter. Internode 45-60 cm long.

Culm sheaths - 20 cm long, thin, longitudinally wrinkled and striate, covered with appressed golden or black hairs. Leaves are broadly oblong and lanceolate.
Propagation - Mainly by seeds. Germination was about 40 to 50 percent. Viviparity is observed. The seeds are viable only for one month. Propagation is by rhizomes also. Treatment with NAA enhance rooting response and vigour of rooted cuttings. (Seethalakshmi, 1993). 

Uses - For superior quality pulp, rayon manufacture.

Aims and objectives of present research endeavour

At present the literature reveals that there is no attempt so far to raise these economically important plants by tissue culture methods. So the main aim of the present research work, is to develop in vitro technique for propagation of two important groups of reeds

1. *Ochlandra travancorica*
2. *Ochlandra travancorica var hirsuta*

which are otherwise difficult to propagate by conventional method. These two group of plants are vanishing and in order to meet the plant material demand, the artificial regeneration of these plants are strongly recommended, (Chand Basha, 1991). Experiments were also conducted for evaluating the responses of various tissues cultured in vitro and to study the basic mechanisms involved in the development in culture.

The following culture techniques were employed in the present study.
1. Micropropagation through axillary bud culture
2. Callus culture
3. **In vitro** flower induction in *O. travancorica*

4. Histological studies

1. The micropropagation using axillary bud has been the most widely used method for *in vitro* clonal propagation, following the successful rapid multiplication of orchids by shoot meristem culture by Morel (1960-65). Micropropagation techniques are now preferred to conventional practices of vegetative propagation because
   a) only small amount of tissue is needed for large scale multiplication
   b) large number of plantlets can be regenerated at any time
   c) lakhs of plantlets can be regenerated within a short span of time and space.
   d) production of disease free plants
   e) storage of valuable germ plasm (Chu *et al*, 1986)

2. **Callus cultures** constitute an alternative method of vegetative propagation. Callus has been initiated from different plant parts like leaf, stem, root, embryos, etc. (George and Sherrington, 1984) of many plants except Ochlandra.

   Shoots can be regenerated from callus using appropriate hormonal combination which eventually rooted. Genetic diversity occurs through callus culture resulting in variations in phenotypes in a cell population (Dodds and Roberts, 1985). These changes may be stable, heritable or potentially reversible. In reeds because of the monocarpic nature, the callus culture helps to produce
plants with new genetical characters.

3 The *in vitro* induction of flowering from the multiple shoots is an added advantage in bamboo tissue culture, due to its monocarpic nature. In the breeding purpose, this opens a new area in the crop improvement in reeds. *In vitro* production of viable seeds at any time may help in the future crop improvement programmes.