REPRODUCTIVE BIOLOGY OF *SCHIMA WALLICHII* (DC.) KORTH. AND *SCHIMA KHASIANA* (DYER) BLOEMB.

By

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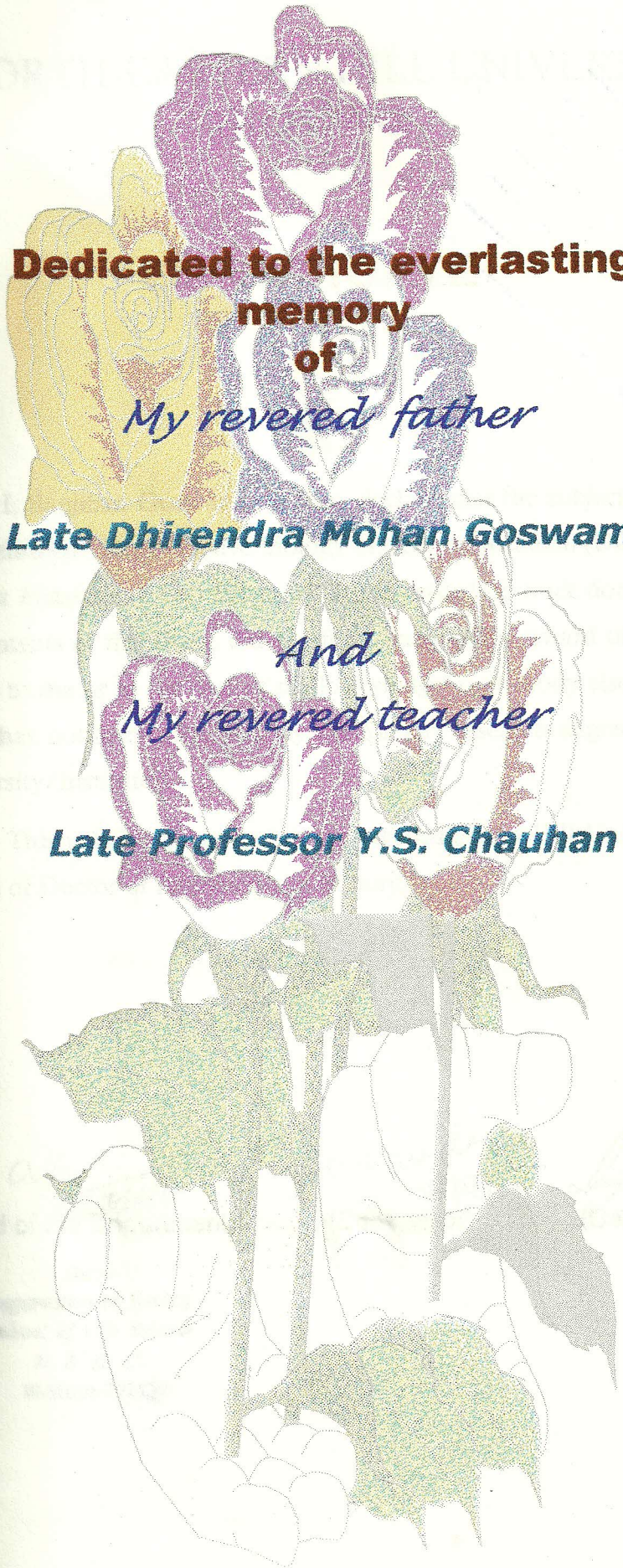
THESIS SUBMITTED

IN FULFILMENT OF THE DEGREE OF

DOCTOR OF PHILOSOPHY IN BOTANY

OF

NORTH-EASTERN HILL UNIVERSITY
SHILLONG, INDIA
2002



Dedicated to the everlasting memory of

My revered father

Late Dhirendra Mohan Goswami

And

My revered teacher

Late Professor Y.S. Chauhan

NORTH-EASTERN HILL UNIVERSITY
SHILLONG

CERTIFICATE

I, Sanjiban Goswami, hereby, declare that the subject matter of the thesis entitled "Reproductive biology of *Schima wallichii* (DC.) Korth. and *Schima khasiana* (Dyer) Bloemb." is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Botany.

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ACKNOWLEDGEMENT

I express my deepest reverence and profound gratefulness to late professor Y.S.Chauhan of the Department of Botany, North-Eastern Hill University, Shillong, under whose tutelage and hallowed guidance, the present study was undertaken. The present study was conceptualized and moulded by his enduring scholastic skills and received his inspiring guidance. Unfortunately, his abrupt demise halfway through the execution of the study came as a shattering blow. I take this opportunity to offer my respectful homage to him.

Words are inadequate to express my gratefulness to Professor H.N. Pandey, former Head, Department of Botany, NEHU, who was generous enough to supervise the work in the absence of Late Professor Y.S. Chauhan and offered his invaluable critical comments notwithstanding his kind permission to use laboratory facilities.

My sincere gratitude is extended to Professor R.R.Mishra, former Head of the Department and to Professor A.K.Mishra, present Head, Department of Botany, North-Eastern Hill University, Shillong, for providing necessary facilities for my research work.

It shall grossly inappropriate if I do not record my grateful thanks to Professor A.K. Pandey of the Department of Botany, TM Bhagalpur University, Bhagalpur, who inspite of his busy schedule so kindly agreed to peruse the manuscript and

imparted it the much needed direction and coherence that it lacked. I am ever grateful to him.

I am also grateful to Professor R.S. Tripathi for his useful suggestions and constant encouragement .My sincere thanks also go to Professor Chih-Hua Tsou, Institute of Botany, Academia Sinica, Republic of China and Dr. S.C. Naithani, School of Life Sciences, Pt. Ravishankar Shukla University, Raipur, for providing moral support and extending their generous help on many occasions.

I would like to place on record my sincerest appreciation to Mrs.S.Chauhan and all her family members whose constant encouragement was very vital to the proper completion of the present investigation.

I am obliged to Dr. N.Venugopal, Dr. L.Kharluki, Dr.Y.Kumar, Dr.M.S.Dkhar, and Dr.S.Kumaria for their suggestions and encouragement.

Thanks are due to the Head, RSIC, NEHU, Shillong, for his necessary permission to undertake electron microscope photography for my work.

My fellow laboratory mates viz. Dr.S.R.Katiyar, Miss.Rashi, Mrs. H. Jamir and Mr. D. Singh deserve appreciation for their constant care, affection and ever-willing attitude during the study period.

I wish to thank the Principal St. Edmund's college, Shillong for his helpful suggestions and comments. Help and cooperation that was always forthcoming from my colleagues in the Department of Botany, St Edmund's college is gratefully acknowledged.

I am obliged to all the staff of the Department of Botany, Life Science library and the drivers of the university especially Mr. Bamuddin whose timely help and unconditional assistance in fact paved the way for the successful completion of the study.

My Sincere thanks to all my friends especially Dr.S.DasGupta, Mr. A.Bhattacharjee, Ba Will, Mr. H.Choudhury, Mr. G.Baidya, Dr.Babu John, Mr.D.Deb, Mr.B.Rathore, Mr.S.Bhattacharjee, Mr.D.M.Goswami, Mr.B.Bhattacharjee, Mr.S.Dutta Purkayastha, Miss J.Goswami, Miss A.Chowdhury, Miss B.Ghosh without whose close involvement the study would not have led to its logical conclusion.

Last but not the least, I place on record my heartfelt tribute to my father Late Dhirendra Mohan Goswami without whose blessings I would not have been able to complete the study. I am ever grateful to my esteemed Mother, Brothers, Sisters, Brother-in-laws, Sister-in-laws, Nephews for their undying love and affection, generosity and encouragement throughout the study period.

Shillong

Dated ; 9th April, 2002

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INTRODUCTION

India is rated among the few mega-diversity centres in the world. However, in spite of the occurrence of different variety of plant forms, the actual forest cover is only 64.20 million ha which works out to 19.52 percent of the 323 million ha total geographic area of the country; The National Forest Policy (1988) fully reflects the concern for the protection of forests as well as improvement in their productivity and aims at one third of the total land area to be under forest or tree cover. Tropical forests provide a wealth of timber and non-timber products, many of which have been traditionally used by local people for generations. The current high rate of deforestation threatens the genetic resources of these species, reducing the ability of these forests to meet local requirements. The challenge is to increase the quality and quantity of productivity per unit area. Now-a-days, indigenous species are increasingly being planted for social forestry and environmental stability. Sufficient information is available on the choice of species for different regions and plantation zones. A number of species currently in use in plantations programmes in the country. Prominent among these species are *Dalbergia sissoo*, *Tactona grandis*, *Alianthus excelsa*, *Anthocephalus cadamba*, *Gmelina arborea*, *Casuarina equesitifolia* etc. and different species of *Acacia*, *Albizzia*, *Prosopis*, *Terminalia*, *Bauhinia*, *Cassia*, etc. Analysing the yield in a number of plantations, it was observed that poor yield in many plantations is due to poor quality of seeds.

Perennial habit of trees, phenomenon of juvenility, seasonal flowering, long generation time and limited flowering periods, difficulty in experimental manipulation due to large plant size are some of the reasons why research in reproductive biology of trees has lagged behind (Sedgley and Griffin, 1989).

Flowering of tree crops is a highly complex process, which involves many developmental stages. These stages must proceed successfully for the realization of yield potential. There have been few studies of floral induction in trees (Hartly, 1970; Menzel, 1984; Sedgley, 1985; Westwood, 1978).

A number of physiological features associated with the reproductive process can influence the breeding system of a plant species. These features generally result in a breakdown or abnormality in the sequence of flower and fruit development. Floral development in addition to floral initiation is influenced strongly by temperature. Flowering in most woody perennials does not appear to be under photoperiodic control except *Rhododendron, Picea, Hibiscus and Malus* (Moss, 1969). In these trees, the differentiation of the generative tissues appears to be particularly sensitive to temperature.

Low fruit set in nature may be largely due to a high incidence of self-pollination and a high degree of self-incompatibility, but several other causes such as resource limitation and position of fruit within inflorescence, may also be involved (Bawa and Webb, 1984). The low fruit to flower ratio is generally found in hermaphrodite plants, which exhibit self-incompatibility (Sutherland, 1986).

There is an ever-increasing demand for timber as a raw material for construction, fuel wood, furniture and industrial fiber. It is estimated that forest in developing countries have declined by nearly half during last century and that 11 million hectares of tropical forest are currently being cleared for alternative uses such as agriculture (Smith, 1985).

The National Commission on Agriculture in its report estimated the requirements of industrial timber to be of the order of 47-64 million cubic meters. Apart from this, the additional requirements for wood will be to the tune of 48-66 million cubic meters. This gains added significance as the tree species are of immense value for their timber and fuel wood purposes and as such, large scale plantation of fast-growing trees are being raised for the above purpose.

The production of high percentage of viable seeds with a capacity to germinate quickly is an ideal pre-requisite for the proliferation of such tree species.

Of late, there has been renewed thrust to impart greater impetus to the various aspects of reproductive biology with a view to adopt either mono- or mixed cultures of trees or both. Such studies encompass a broad spectrum of features viz., phenology, floral biology, pollen-pistil interactions, pollen viability, pollen germination and seed development resulting in the healthy raising of tree seedlings.

The North-Eastern region of India is a treasure house of plant resources and occupies a unique geographical position in terms of agricultural and industrial production potential. The high rainfall and considerable variation in ecological conditions prevailing in the region has resulted in an environment in which a wide range of plants can be grown for the production of medicinal, aromatic (perfumery) materials, timber wood, fuel wood, essential oils etc. Despite varied flora in North-Eastern region, not many efforts have been made to utilize the forest resources especially from industrial point of view.

The pentropical family Theaceae is one of the largest families of Theales (s.l.) and includes 25 to 30 genera (see Tsou, 1995). Many of its members are common trees or shrubs in lowland forests. The genus *Schima* occurs only in tropical and sub-tropical Asia (Tsou, 1997). The number of species of *Schima* varies from one (Mabberley, 1987) to 30 (Wu, 1984). Keng (1978) reduced all Malayan *Schima* species into *Schima wallichii*. Mabberley (1987) took this single species to represent the whole genus. Morphological, anatomical and embryological features support a multispecies *Schima* (Tsou, 1997). However, members of Theaceae, to which *Schima* belongs, besides having no means of vegetative reproduction, have multilocus gametophytic incompatibility and hence rely on pollen-eating insects for reproduction (Richards, 1986).

Schima wallichii (DC.) Korth. and *Schima khasiana* (Dyer) Bloemb. are timber trees of commerce restricted to eastern Himalayas, N. E. region of India,

Bangladesh, Myanmar, Nepal, Bhutan and China. Meghalaya, the tiny hilly state of North-Eastern region is blessed with a rich diversity of flora and fauna. Among the various tree species known to grow in this region, important tree species namely *Schima wallichii* is endemic to North-Eastern region and *Schima khasiana* is endemic to Meghalaya (see Chauhan *et al.*, 1996). *Schima wallichii* trees occur in plains and on the hills between 1200-1700 m altitude. *Schima khasiana* trees do not occur in plains and confined between 1200-2000 m altitude. In Meghalaya they are present mostly in sacred forests at Jowai, Sohrarim, Pongtung etc. These two pioneer species of sub-tropical broad-leaved forests of North-Eastern India are useful for afforestation and ecorestoration of degraded lands of this region. However, natural regeneration of *Schima wallichii* and *Schima khasiana* suffers due to high seed sterility (50%), poor seed germination and high (80 – 90%) seedling mortality (Boojh, 1981). In *Schima khasiana*, the distance from the parent tree decreases seed predation and increases germination. Germination of seeds in case of *Schima khasiana* has been found to be better in disturbed strands. An alteration in forest microclimate and microsite characteristics, consequent upon the exposure of the forest floor to insolation, favoured both seed production and germination in the shade-intolerant *Schima khasiana* (Barik *et al.*, 1996). High survivorship and high growth rates of *Schima khasiana* seedlings in large gaps is indicative of the regeneration niche preferred by this species (Rao *et al.*, 1997).

Schima wallichii is an out breeding species and is also inefficient reproductively (Chauhan *et al.*, 1996). The species suffers from more than 50% seed sterility and approximately 80 – 90% seedling mortality (Boojh, 1981). The investigations on pollen viability indicate that only one-third of pollen is viable (Chauhan *et al.*, 1996).

Keeping above facts in view, the present work has been done on phenology, floral biology, pollination mechanism, pollen-pistil interaction and seed development in the important timber-yielding trees of North-Eastern region of India.