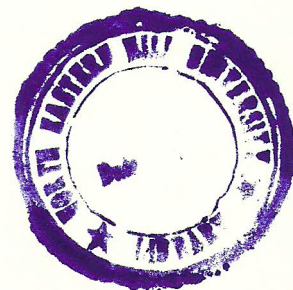


**ECOPHYSIOLOGICAL STUDIES OF TERRESTRIAL ORCHIDS OF MEGHALAYA
WITH SPECIAL REFERENCE TO *Paphiopedilum* SPECIES**

By

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Thesis Submitted in Fulfilment of the Degree of
Doctor of Philosophy in Botany



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I certify that the thesis entitled "Eco-physiological studies of terrestrial orchids of Meghalaya with special reference to *Paphiopedilum* species" submitted by Miss Sabina Rynjah, for the degree of Doctor of Philosophy of North-Eastern Hill University, Shillong embodies the record of original investigation by her under my supervision. She has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. Degree. The work has not been submitted for any degree of any other university.

29th December, 1993

Shillong

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CONTENTS

	Page
Preface	i
Acknowledgements	ii
Chapter 1. General Introduction	1
Chapter 2. Review of Literature	6
Chapter 3. Study Site	18
Chapter 4. Geographical Distribution of <i>Paphiopedilum</i> species	21
Chapter 5. Morphology, Phenology and Anatomy of <i>P. insigne</i> and <i>P. villosum</i>	29
Chapter 6. Effect of watering on growth performance	45
Chapter 7. Effect of substrate quality on growth performance	65
Chapter 8. Effect of light intensity on growth performance	79
Chapter 9. Effect of soil nutrient level and light intensity on growth performance	91
Chapter 10. Effect of offshoot density on growth performance	113
Chapter 11. General Discussion	127
Summary	133
References	137

PREFACE

The thesis embodies the results of an ecophysiological study of two species of a terrestrial orchid *Paphiopedilum*, commonly known as 'Lady's slipper'. The two species, *P. insigne* and *P. villosum* which are endemic to the north-eastern region of the country and have great ornamental value are fast dwindling in their natural haunts due to over-exploitation and destruction of forests. The present study aimed at collecting relevant information and experimental data regarding distribution, morphology, phenology and ecological responses of these two species at certain climatic conditions and edaphic variables of environmental complex.

The thesis has been divided into 11 chapters. Chapter 1-5 include the General Introduction, Review of Literature, Study Site, Geographical Distribution and Morphology, Phenology and Anatomy of *Paphiopedilum*. Chapter 6-10 deal with the growth responses of these two species to watering, substrate quality, light intensity, soil nutrients level and offshoot density. Each of the above chapters has a brief introduction, method of study, results and a brief discussion.

A synthesis of the results of the entire study has been presented in the General Discussion which is followed by the summary and references.


(SABINA RYNJAH)

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Chapter 1

GENERAL INTRODUCTION

Orchids are a unique group of flowering plants that show a wide range of diversity in size, structure, number, colour and fragrance of flowers. There are approximately 750 genera (Khoshoo 1986), and 20,000 species of orchids in the world (Cribb 1986). They are distributed all over the world, except the Antarctica, and constitute one of the largest family of the flowering plants (Rittershausen and Rittershausen 1984, Khoshoo 1986).

In India, Orchidaceae is the second largest family of the flowering plants, next to the Gramineae (Jain 1986). About 1300 species of orchids occur in the north-eastern region of the country.

Orchids are popularly known as showy ornamental plants on account of their fascinating and long lasting flowers. Even the cut flowers remain fresh for a long time.

Credit for growing orchids for ornamental purposes goes to the Britishers. During the first half of the 18th century, when the British Empire expanded around the world, orchids were collected and sent to England in large numbers. Some of them died during the journey before they could reach England, while many others survived, flourished and flowered in the expert hands of early orchid lovers. In 1832, John Lindley, Professor of Botany at the University of London, who was the foremost authority on orchids at that time, could not succeed in growing them under controlled conditions. However, during the same period Joseph Paxton, a gardener of the *Duke Of Devonshire*, demonstrated

that orchids can be grown and flowered successfully in the British Isle. After that time orchid growing became very popular in whole England.

During the second half of the 19th century, orchids were exported in large numbers to England from different countries in the tropics. They were auctioned for large sums of money in the sales room of Protheroe and Morris & Stevens in London. For example, at one time a single plant of *Odontoglossum crispum* was sold at a price of £1500. In 1851, the *Crystal Palace* in England on its opening day was adorned with two tons of Leopard Orchids (*Grammatophyllum speciosum*) imported from the East Indies. The trade of wild orchids at that time caused great damage to many species and they could never be recovered. Many orchid species now a days are not found in wild. For instance, the blue *Vanda* (*Vanda coerulea*) and the charming slipper orchids *Paphiopedilum fairieanum* have been missing from their former distributional ranges of Assam. *Odontoglossum crispum* and *O. pescatorei* of Columbia, *Cattleya* of Brazil, the white and pink *Vanda sanderiana* and the moth orchids, *Phalaenopsis schleriana* and *P. stuartiana* of Philippines have faced rarity.

Orchids with fantastic range of variation in their floral structure have attracted the attention of not only the botanists, but laymen as well. The orchid breeders took interest in propagating and producing new hybrids, as a result, wild orchids were in great demand. In England alone, nearly a quarter of 49 native species have become endangered and two species *Spiranthes aestivalis* and *Epipogium aphyllum* have been probably extinct. The ghost orchid *Epipogium aphyllum* has been missing for 3

consecutive years, while the monkey orchid *Orchis simia*, military orchid *Orchis militaris* and the lizard orchid *Himantoglossum hircinum* are all facing danger of becoming extinct. The lady's slipper orchid *Cypripedium calceolus* was reduced to a single plant in its sole remaining locality, as a result of its large scale removal from the wild over the years. Thus in order to protect and propagate as well as to introduce endangered European orchids in England, a programme was initiated at the Royal Botanic Garden, Kew some time in 1983 (Bailes *et al.* 1986).

Several orchid species were named after eminent early orchid growers. For instance, *Cymbidium dayanum*, *Paphiopedilum dayanum* etc. were named after John Day and a spectacular genus *Cattleya* was named by Lindley after William Cattleya who first grew the tropical orchids in England.

Scientific studies on orchids in India are lagging behind except for taxonomy, embryology, cytogenetics and a few tissue culture studies (Kataki 1963, 1976, Karanth *et al.* 1981, Sharma and Vij 1981, 1982, Sood 1984, Biswas 1986, Muralidhar and Mehta 1986, Vij and Shekhar 1986, Chaturvedi and Sharma 1986, Vij and Pathak 1990). The records of orchid growing in our country are indeed very poor. In this direction, sincere efforts have been made by Dr. Valluri at Bangalore, Dr. Govindachari at Madras, Professor Abraham at Trivandrum and some professional groups such as the Pradhans of Sikkim. Therefore, the knowledge about the biology of most of our orchids is still far from complete. Recently, collection, study and conservation programmes have been taken up by the Botanical Survey Of India, Orchid Research Station at Arunachal Pradesh and by the West Bengal Government.

In India orchid dealers are not so elaborately equipped for the propagation or breeding of orchids and the main source of their supply for commercial purposes is the forests. As a result, a near depletion and extinction of many attractive wild orchids have begun to take place from their natural haunts. Many of them are now endangered in the wild, those surviving the exploitation of the collectors, suffer from habitat destruction.

The north-eastern India is the richest geographical region for orchids in the country, yet our knowledge about orchids of this region is very poor, because the forests of this region are unexplored due to difficult terrain, adverse climatic conditions and even local conditions (Joseph 1986).

In India and even abroad, ecological studies on *Paphiopedilum* species have not been undertaken. A few physiological studies have been carried out by Nelson and Mayo (1977), Rutter and Willer (1979) and Assmann and Zeiger (1985). Studies on the ecology of other orchid species are also very few. A brief account of ecology of orchids has been given by Withner (1974). Rathore (1982) wrote an ecological note on *Cymbidium aloifolium*. Keddy et al. (1984) studied the ecology of *Cypripedium passerinum* while Calder et al. (1989) carried out ecological investigations on *Thelymitra epipactoides* F. Muell. A few studies on the habitat conditions and distribution of orchids have been carried out (Hegde 1982, Sara et al. 1985, William et al. 1985). Hutchings (1987) observed the population biology of *Ophrys sphegodes* Mill. Whigham (1984) studied the biomass and nutrient allocation in different plant parts of *Tipularia discolor*.

The genus *Paphiopedilum* commonly known as Lady's slipper bears attractive flowers and has high commercial value. The present ecological study has been done on two species of *Paphiopedilum* - *Paphiopedilum insigne* Pfitz. and *Paphiopedilum villosum* Stein. It includes detailed study of distribution, phenology, morphology, anatomy and effects of watering, substrate quality, light regime, interactive influence of light regime and soil nutrient level and offshoot density on the growth behaviour of both *P. insigne* and *P. villosum*. The results of these experiments have been presented and discussed in the following 1-11 chapters of the thesis.

- Chapter 1. General introduction
 - Chapter 2. Review of literature
 - Chapter 3. Study site
 - Chapter 4. Geographical distribution of *Paphiopedilum*
 - Chapter 5. Morphology, phenology and anatomy of *Paphiopedilum*
 - Chapter 6. Effect of watering
 - Chapter 7. Effect of substrate quality
 - Chapter 8. Effect of light regime
 - Chapter 9. Effect of light intensity and soil nutrient level
 - Chapter 10. Effect of offshoot density
 - Chapter 11. General discussion
- Summary