BOTANY
FOR DEGREE STUDENTS
GYMNOSPERMS

Dr. P.C. VASISHTA
Dr. A.K. SINHA
Dr. ANIL KUMAR

S. CHAND

MULTICOLOUR ILLUSTRATIVE EDITION

Botany for
Degree Students

Gymnosperms

MULTICOLOUR ILLUSTRATIVE EDITION

Botany for Degree Students

Gymnosperms

P. C. VASISHTA
M.Sc. (Hons. Sch.) ; Ph.D.; P.E.S. (I)
Retd. Ex Principal, Government College for Boys Chandigarh and D.A.V. College, Hoshiarpur

Revised by

A.K. SINHA
M.Sc., Ph.D.; F.P.S.I.
Reader & Head (Retd.)

ANIL KUMAR
M.Sc., Ph.D.
Reader

Dept. of Botany
Feroz Gandhi (P.G.) College
Raebareilly

S. CHAND & COMPANY LTD.
(AN ISO 9001 : 2000 COMPANY)
RAM NAGAR, NEW DELHI -110 055

S. CHAND & COMPANY LTD.

(An ISO 9001 : 2000 Company)

Head Office : 7361, RAM NAGAR, NEW DELHI - 110 055
Phones : 23672080-81-82; Fax : 91-11-23677446
Shop at: **schandgroup.com**
E-mail: **schand@vsnl.com**

Branches :

- 1st Floor, Heritage, Near Gujarat Vidhyapeeth, Ashram Road, **Ahmedabad**-380 014. Ph. 27541965, 27542369
- No. 6, Ahuja Chambers, 1st Cross, Kumara Krupa Road, **Bangalore**-560 001. Ph : 22268048, 22354008
- 152, Anna Salai, **Chennai**-600 002. Ph : 28460026
- S.C.O. 6, 7 & 8, Sector 9D, **Chandigarh**-160017, Ph-2749376, 2749377
- 1st Floor, Bhartia Tower, Badambadi, **Cuttack**-753 009, Ph-2332580; 2332581
- 1st Floor, 52-A, Rajpur Road, **Dehradun**-248 011. Ph : 2740889, 2740861
- Pan Bazar, **Guwahati**-781 001. Ph : 2522155
- Sultan Bazar, **Hyderabad**-500 195. Ph : 24651135, 24744815
- Mai Hiran Gate, **Jalandhar** - 144008 . Ph. 2401630
- 613-7, M.G. Road, Ernakulam, **Kochi**-682 035. Ph : 2381740
- 285/J, Bipin Bihari Ganguli Street, **Kolkata**-700 012. Ph : 22367459, 22373914
- Mahabeer Market, 25 Gwynne Road, Aminabad, **Lucknow**-226 018. Ph : 2626801, 2284815
- Blackie House, 103/5, Walchand Hirachand Marg , Opp. G.P.O., **Mumbai**-400 001. Ph : 22690881, 22610885
- 3, Gandhi Sagar East, **Nagpur**-440 002. Ph : 2723901
- 104, Citicentre Ashok, Govind Mitra Road, **Patna**-800 004. Ph : 2300489, 2302100

Marketing Offices :

- 238-A M.P. Nagar, Zone 1, **Bhopal** - 462 011. Ph : 5274723.
- A-14 Janta Store Shopping Complex, University Marg, Bapu Nagar, **Jaipur** - 302 015, Phone : 2709153

First Edition 1976
Subsequent Editions and Reprints 1976, 78, 80, 81, 83 (Twice), 85, 86 87, 89, 90 1991, 92, 94, 95, 96, 98, 99, 2001, 2004
Reprint 2005

First Multicolour Illustrative Revised Edition 2006

ISBN : 81-219-2618-1

PRINTED IN INDIA

By Rajendra Ravindra Printers (Pvt.) Ltd., 7361, Ram Nagar, New Delhi-110 055 and published by S. Chand & Company Ltd. 7361, Ram Nagar, New Delhi-110 055

Preface to the Revised Edition

This thoroughly revised, improved and multicoloured edition of this popular book **"Botany for Degree Students—Gymnosperms"** has been brought out for the benefit of undergraduate and post-graduate students. While the original format remains unchanged, lot of matter has been added. A new chapter dealing with recent topics like Experimental Embryology and Biotechnology and application of biotechnology, world distribution of gymnosperms, impact of gymnosperms on human society and areas to be explored in studies of gymnosperms is an added attraction. In addition, each and every chapter in the book has been thoroughly revised and wherever needed, recent matter has been added. All the diagrams have been redrawn and several new diagrams have been added. As per the new trend of question papers, the three types of questions essay type, short answer type and objective type questions have been added. We have taken materials from the research journals and recent textbooks. The editors wish to express their sincere gratitude to the authors of the research papers and books and to their publishers.

We have been guided and assisted by a number of university and college professors and friends. We express our grateful thanks to each one of them.

Our heartiest thanks are due to Mr. R.K. Gupta, Managing Director, Shri R.S. Saxena, Shri Navin Joshi, General Manager (Sales and Marketing), Ms. Malini Kothiyal Asstt. Editor, Mr. Santosh Kumar Singh Asstt. Editor & Mr. Kaliram, Sr. D.T.P. Operator for their help, encouragement and cooperation in bringing out the book in this improved form. It is hoped that this multicolour, revised and improved edition of the book will prove more useful to all its users.

Suggestions for further improvement of this book will be gratefully accepted and acknowledged.

A.K. Sinha
Anil Kumar

Preface to the First Edition

This text has been written in a manner to suit the needs of degree students of Indian Universities. It is fifth in the series Botany for Degree Students that was started by my father in the year 1960, and describes the morphology and reproduction of both living and fossil gymnosperms. Special care has been taken to present the subject matter in a simple and lucid style and to include maximum of recent information available uptodate. Large number of research papers have appeared and many new horizons of both living and fossil forms have been unravelled. Much work has been done on the fossil gymnosperms and several details, hitherto unknown, have been brought to our knowledge. The works of Arnold, Andrews, Florin, Delevoryas, Beck, Taylor, Eggert, Miller, Rothwell, Phillips, Crepet, Banks, and Jennings needs special mention. In India Awasthi, Bharadwaja, Bose, Chowdhury, Ganju, Ghosh, Gupta, Jain, Mehta, Pant, Prakash, Tripathi, Sahni, M.R. Srivastava, Sharma, and Vishnu Mittre have done much work on the fossil gymnosperms and have kept up the tradition started by the Indian stalwarts of the calibre of Birbal Sahni and M.B. Raizada. Lot of work has been done on the living gymnosperms and in this context names of Prof. P.N. Mehra, Prof. P. Maheshwari, Prof. B.M. Johri, Prof. T.N. Khoshoo, Prof. D.D. Pant, Dr. L.N. Rao, Prof. R.N. Konar, Dr. R. Khan, Dr. Hardev Singh and their students will be remembered for ever. The works of Coulter and Chamberlain, Chamberlain, Pearson, Thomas, Thompson, Sporne, Martens, Waterkeyen, Namboodari, C.B. Beck, T.A. Steeves, Alosi and Alfieri and large number of other workers have added a great deal to our knowledge of extant gymnosperms. In writing the present text the author has tried to consult all the available literature and especially by the above mentioned botanists of international fame. The author takes this opportunity to express his deep sense of gratitude to these famous botanists and the publishers of the books and journals that contain the valuable information.

The illustrations, wherever possible, have been drawn from original specimens and slides. A number of photographs have been given. All of them have been taken by the author from various places in India. They clearly illustrate the morphological features of plants and give an actual and a clear picture of the habit and external features of the sporophytes.

I am indebted to my father Prof. B.R. Vasishta who has introduced me in this series and from whom, besides inheriting my interest in the subject of botany, I have inherited the capacity to write. I express my deep sense of gratitude to Prof. Y.P. Oberoi for sending me reprints of his research papers and some other valuable papers on various aspects of gymnosperms. In this context I am also grateful to Prof. Tej Nath Lakhanpaul, Prof. P.S. Gill, Prof. V.P. Chadha, Prof. K.P. Sood, Prof. S.P. Kanwal, Prof. S.S. Malik, Prof. M.S. Sethi, and many other friends in India and abroad. I also thank Mr. Muni Lal Verma, the artist for taking keen interest in drawing illustrations for this book. I shall be failing in my duty if I do not thank my publishers M/s. S. Chand & Company Ltd., who have extended me full co-operation during the process of printing this book and in bringing it out in the present form.

I request my colleagues all over India to send me their healthy criticism and their useful suggestions to improve the book.

AUTHOR

CONTENTS

GNETUM MALE STROBILUS

CHAPTER 1

Introduction

- Characteristic features
- Reproductive Organs
- Embryogeny
- Origin of Gymnospermous Structures
- Classification of Gymnosperms
- Gymnosperm in India, their distribution and Economic Importance
- Comparisions with Pteridophytes and Angiosperms
- Indian contribution on Gymnosperm
- Progymnospermopsida: Archaeopteris

The word '**Gymnosperm**' was used in 300 B.C. by Theophrastus, a pupil of Aristotle, in his book "Enquiry into Plants". Theophrastus used this term to embrace all those plants whose seeds are unprotected (*Gymnos* = naked; *sperma* = seeds). The seed plants (Spermatophyta) are grouped into two major groups on the basis of protection afforded to the ovule before and after fertilisation. These groups are the **gymnosperms** and the **angiosperms**. The gymnosperms have their **ovules** freely exposed before and after fertilisation. They are not enclosed by any ovary wall, whereas in the angiosperms (*angios* = vessel; *sperma* = seed) the ovule or the ovules are completely

enclosed within a structure called the **ovary**, which forms the lower distended part of the **carpel**. Due to the protection afforded to the ovule and the seed, the angiosperms are considered to be advanced than the gymnosperms, which are, therefore, regarded as intermediate between the **pteridophytes** and the **angiosperms**. The evolutionary high status of angiosperms and their conquest over other groups of the plant kingdom is due to their

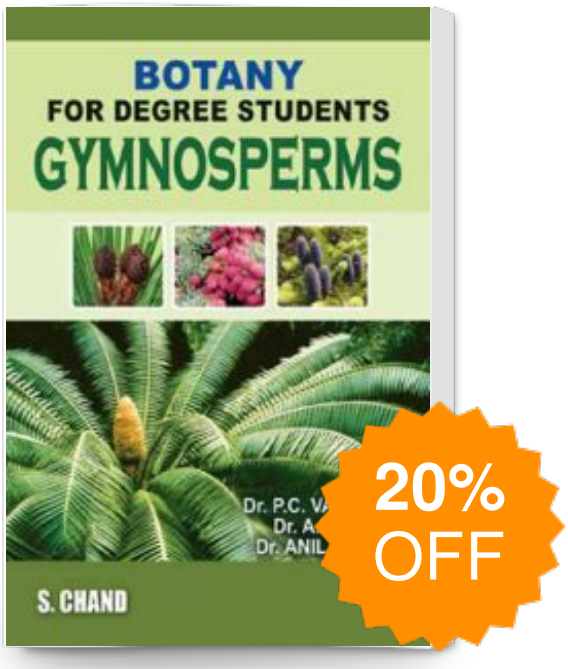
- diversified habit and vegetative forms;
- higher degree of perfection of the vascular system; the xylem in addition to the tracheids, contains wood vessels, and the phloem possesses companion cells;
- successful invasion of all habitats;
- adaptation of flower to insect pollination;
- bisexual flower, the bisexuality ensures self-pollination if cross-pollination fails, hence the seeds are formed in any case;
- development of ovules within the ovary which ensures proper protection to the developing ovules and seeds;
- efficient and effective dispersal by insects, birds, other animals, wind, water and by many other specialised mechanisms;
- efficient and varied means of vegetative propagation, which result in rapid multiplication;
- their utmost economic importance; and
- besides the above listed reasons, there must be some hereditary causes such as better equipment of gene potential and useful gene mutations, which enabled them to encounter variations in temperature and other environmental changes and led to their conquest over other plant groups.

The gymnosperms are not in such an advantageous position because :

- they lack vegetative means of reproduction by means of cuttings, layering, etc., and are slow growers;
- limited means of dispersal (only wind and by man) and their failure to grow under varied habitats (*e.g.*, water);
- absence of vessels (a few exceptions are there) in xylem and of companion cells in the phloem;
- absence of bisexuality which reduces the chances of self-fertilisation and lot of pollen is wasted as wind pollination is the main source of carriage of pollen grains;
- unprotected ovules and seeds and
- their decline may also be due to the running out of the gene potential for environmental adaptation and appearance of certain harmful mutations and chromosomal alterations. Due to their beautiful foliage and stately appearance, man has attempted and is attempting to grow them in his gardens, but with little success, because they are slow growers and have little means to adapt to varied habitats. Economically too they are less important as compared to angiosperms.

In both the gymnosperms and the angiosperms, the sporophyte, in the course of evolution has become perfected to adapt to the various environmental conditions, composed of widely different land habitats, and climates of plains, of mountains and valleys of oceans and rivers and their bank and shores, of deserts and of a great variety of micro-environments. Through millions of years of evolution, the sporophyte of the seed plants was organised, capable of bracing the terrestrial environments. That the evolutionary experimentation leading to death was still at work at the stage of origin of the seed plants, is supported by the fact that the early gymnosperms became extinct in the same way as the early pteridophytes. The origin of angiospermous plant-body represents, perhaps the last or say latest outcome of sporophyte evolution in the plant kingdom. The sporophyte of the seed plants is the only visible individual bearing the '*gametophytes*', both male and female. The male gametophyte or the '*pollen grain*' is mobile whereas the female gametophyte or '*megaspore*' is '*quiescent*' and en-

Botany For Degree Students-Gymnosperms



Publisher : SChand Publications ISBN : 9788121926188

Author : P.C. Vasishta, A.K. Sinha, Anil Kumar