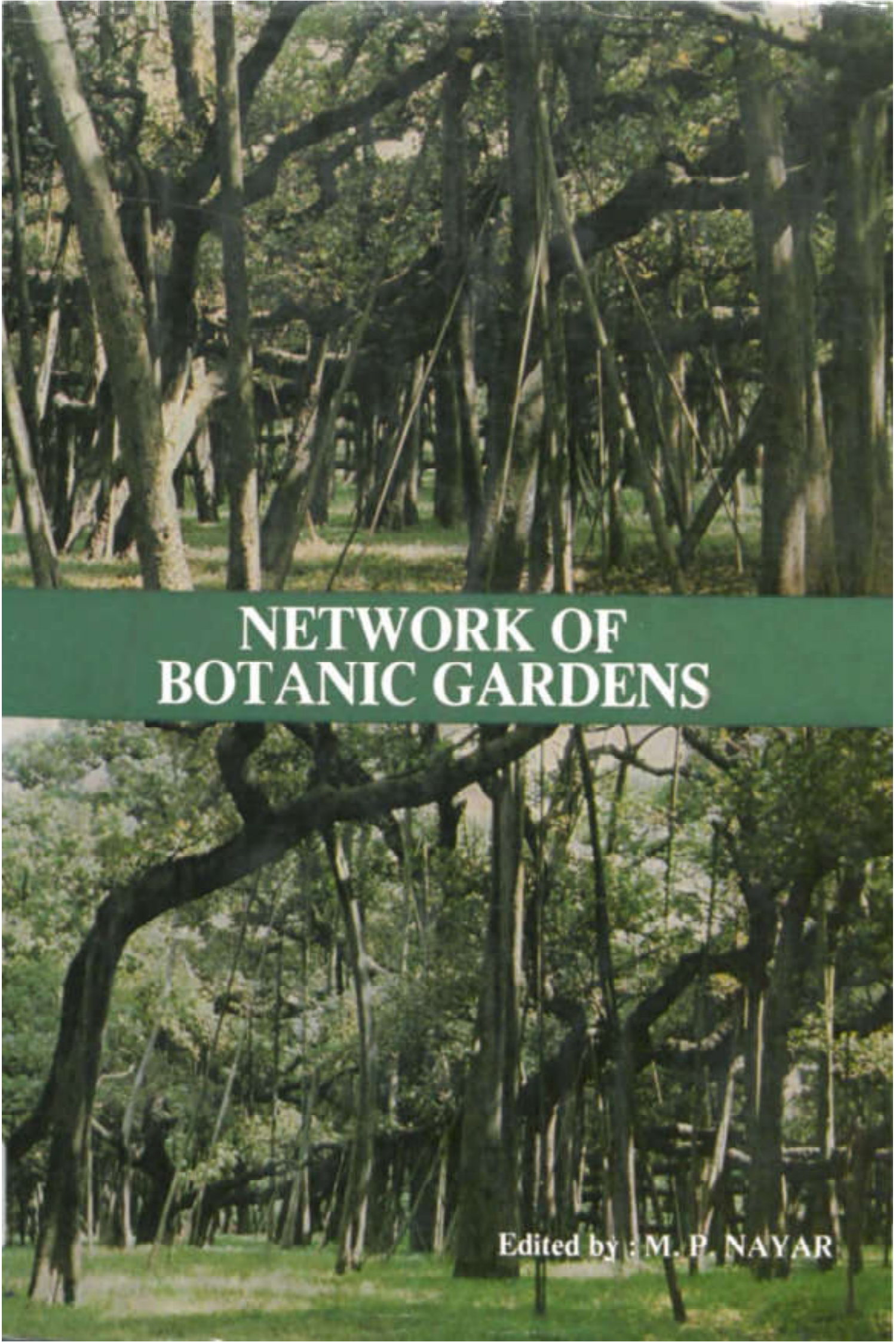


NETWORK OF BOTANIC GARDENS

Edited by : M. P. NAYAR

ABOUT THE BOOK

This volume on "Network of Botanic Gardens" is published by the Botanical Survey of India on the eve of the Bicentenary of the Indian Botanic Garden (1787–1987). Thirty three well known gardens of the world responded to our invitation and it is the result of the generous response from the Directors of these well known gardens, at least three of these have already celebrated their tricentenary. This volume is edited by Dr. M. P. Nayar, Director, Botanical Survey of India.

The greatest concern which botanic gardens of the world face today is the plant extinctions due to habitat destruction. Though seed plants appeared hundred million years ago when dinosaurs roamed the earth, due to man's greed the trees have become "wooden dinosaurs" of this century. It is said that we are loosing 60 hectares of forest every minute throughout the world.

In the world conservation strategy, Botanic Gardens can play a role of fire brigade action for conservation of the endangered species. A network of botanic gardens cultivating rare, vulnerable and endangered plant species, exchanging information and plant material would go a long way in preserving the floristic and genetic germplasm which we have inherited as product of millions of years of evolution. It is felt that this awakening of the need to conserve our plants which is our heritage for the benefit of our grandchildren is a great responsibility which we botanists owe to posterity.

"Network of Botanic Gardens" is presenting a panoramic view of beautiful plants and the botanists who strived for preserving this spectrum of plant diversity.

NETWORK OF BOTANIC GARDENS

NETWORK OF BOTANIC GARDENS

(BICENTENARY VOLUME OF INDIAN BOTANIC GARDENS)

Edited by
M. P. Nayar

Botanical Survey of India

Price : Rs. 460.00 $ 80.00 or £ 60.00

Published by the Director, Botanical Survey of India, P-8 Brabourne Road, Calcutta-700001 and
Printed at The Radiant Process Pvt. Ltd., Calcutta.

प्रधान मंत्री के वैज्ञानिक सलाहकार
और सदस्य
योजना आयोग
योजना भवन, नई दिल्ली-110001
SCIENTIFIC ADVISER TO PRIME MINISTER
AND MEMBER
PLANNING COMMISSION
YOJANA BHAWAN, NEW DELHI-110001

Prof. M. G. K. Menon

FOREWORD

I am happy to note that the Indian Botanic Garden, founded on 6th July, 1787, is celebrating its bicentenary over a period of one year, from 6th July, 1987 to 6th July, 1988. This garden, founded by Col. Robert Kyd in 1787, can trace its growth and development through two centuries under the stewardship of eminent personalities like Dr William Roxburgh, Dr Nathaniel Wallich, Dr. Hugh Falconer, Sir George King, Sir David Prain and a host of other personalities. The garden was known at different periods of time as the Calcutta Botanic Garden, East India Company's Garden, Royal Botanic Garden and now the Indian Botanic Garden, as political fortunes changed from one era to the next. The Indian Botanic Garden has played a valuable role in the introduction and cultivation of tea, rubber, cinchona and mahogany in India during the nineteenth century.

The Botanical Survey of India has drawn up plans for celebration of the bicentenary in a befitting manner, by setting up additional facilities of new conservatories, bicentenary gate with exhibition rooms, guest house for scientists and research scholars; and arranging a National Garden festival and an international seminar on the role of botanic gardens for conservation.

We are presently in an era of significant biological extinctions due to loss of habitat, arising primarily through human interference. It is estimated that we are losing 60 hectares of forests every minute throughout the world; this then leads to very heavy and not easily reversible soil erosion, and loss of both soil fertility and of biological diversity. Botanic Gardens can serve as "refugia" for plants driven to the verge of extinction due to habitat loss. There are many new techniques available to botanists for mass culture of species, i.e. tissue culture, meristem culture and somatic fusion of cells to multiply populations close to extinction. Botanical Gardens created on scientific lines can thus play a very important role in conservation of genetic diversities. They can also be centres of excellence for nature conservation activities, and as a base for the campaign for environmental sanity through education and awareness programmes.

particularly by generating a sense of curiosity and interest in children and the up and coming generation. I would like to see such Botanical Gardens established in different ecological regions of the country. These gardens should concentrate first on work relating to endangered species of plants.

I am happy that the Botanical Survey of India is publishing a book on "Network of Botanic Gardens" edited by Dr M.P. Nayar, Director, Botanical Survey of India on the eve of the bicentenary of the Indian Botanic Garden. This, I am sure, will strengthen the establishment of a close network between different botanic gardens. I wish the Indian Botanic Garden and the Botanical Survey of India great success in their efforts.

(M.G.K. MENON)

PREFACE

The rise and fall of botanic gardens in the world's history of gardens is partly due to man's everchanging priorities in life. During sixteenth and seventeenth centuries the botanic gardens in Europe were founded as herbal medicinal gardens or psycho gardens or hortus medicus, since they provided herbal specimens for medical students. The gardens of Padua, Salerno, Bologna, Cordoba, Salamanca, Gessen, Leiden Frankfurt, Montpelier, Arnheim, Basle were the products of the renaissance in herbal medicine in Europe. In the Charaka Samhita, the Materia Medica of ancient India (1000 B.C — 800 B.C.), it is mentioned that medicinal herbs were cultivated in "Tapavanas" near the meditation centres of rishis (saints). The medical school of Alexandria in Egypt founded in memory of Alexander the Great by Ptolemies in 332 B.C. was a repository of herbal medical knowledge of the East which was assembled from the knowledge obtained from the conquered countries of Persia and India. Unfortunately this medical school at Alexandria was burnt down in 391 A.D. Through Greeks, Romans and Arabs, the knowledge of herbal medicine spread to Salerno and Rome in Italy, Cordoba and Salamanca in Spain and Constantinople in Turkish empire.

With the rise of the colonial era during 17th to 20th century when European nations vied with each other for the monopoly of spice trade of the East, the colonial outposts became centres of useful plant introduction from far flung climatically compatible colonial empire. Some of the great gardens of the world *viz.* Royal Botanic Gardens, Kew, Indian Botanic Garden at Calcutta; Botanical Garden at Bogor; Munich Botanical Garden; Botanic Garden of Berlin-Dahlem; Austrian Federal Gardens, Vienna; The Botanic Gardens of Adelaide; Singapore Botanic Gardens; Royal Botanic Gardens, Peradeniya were established during this period. This was an era of unhindered flow of useful plants from the New World to the Old World and vice versa.

With the rise of commercial agriculture and forestry, some of those well known botanic gardens of the world became horticultural gardens and fruit gardens and others became public parks. The cultivation of representative species of plant world lost their charm as this had become financially non-viable. The realisation of the extinction of biota in the offing was not yet felt during this period. As Heywood (1985) appropriately commented "Much of the malaise that besets modern botany and in particular taxonomy and a large part of the explanation of its perennial image-seeking stems from the divorce that has grown up between botany and agriculture and feverish attempts of botanists to seek respectability for their science either as a branch of experimental science or of evolutionary biology or most recently as a part of molecular science" (Bull. Bot. Surv. India 25:135, 1985).

The greatest extinctions of biological species occurred in the Cretaceous period, about 65 million years ago due to geological changes. The extinctions of species during this present century is due to man made habitat destruction. Some of the species which we have seen in our own life time, might become extinct in our life time. The botanists of today have a great role to play in the conservation movement. The taxonomists,

ecologists and environmental managers should come closer and draw up action plans for the conservation programmes of the country. There is great loss of genetic resources and our tropical forests are dwindling at a rate that would lead to the collapse of our civilization based on a few high yielding crop plants unless remedial actions are taken in time. In India about 10% of our plant species is threatened with extinction and we may have to say goodbye 33% of our flowering plants by the time we reach zero growth of our population.

It is heartening to note that one population of *Oryza nivara* occurring in India provided the grassy stunt virus resistance in rice. Another wild species of *Oryza* occurring in Kerala, provided resistance to the Blast disease of rice in Indonesia. One of the recent discoveries of wild germplasm is the perennial maize from Mexico (*Zea perennis* and *Zea diploperennis*) and this would give valuable tool to introduce perennial habit to various cultivars of maize.

In the World conservation strategy, Botanic Gardens can play a role of fire-brigade action for conservation of the endangered species. As ex situ centres of conservation, modern tools are available for the preservation of seeds and propagules in seed banks. A network of botanic gardens cultivating rare, vulnerable and endangered plants, and exchanging information and plant material would go long way in preserving the floristic and genetic germplasm which we have inherited as products of millions of years of evolution.

As a part of the bicentenary of Indian Botanic Garden, Botanical Survey of India is publishing the book "Network of Botanic Gardens" In this publication, the authorities of thirtythree well known gardens have responded to our invitation and send their valuable information of their charter of work and their holdings. Several gardens have promised to send papers and information and this will be published in subsequent publications. The need to conserve our plants which is our heritage for the benefit of our grandchildren is a great responsibility which we botanists owe to posterity.

M. P. NAYAR

ACKNOWLEDGEMENTS

It is my great privilege to thank Prof. M.G.K. Menon, F.R.S., Scientific Adviser to the Prime Minister and Member, Planning Commission for his great interest in the conservation of biological diversity and his encouragements in the development programmes of the Botanical Survey of India. I am indeed grateful to him for writing the foreword.

I wish to express my gratitude to Shri T.N. Seshan, Secretary, Ministry of Environment and Forests, Government of India for his special interest in the Botanical Survey of India's sphere of activities and the bicentenary programmes of the Indian Botanic Garden.

It is a great pleasure for me to record my gratefulness to Dr. B.P. Pal, F.R.S., doyen of our country's botanists for giving me an opportunity to be with him for discussions. Those moments have given me refreshing thoughts on the future programmes of the Botanical Survey of India.

I am extremely grateful to all distinguished contributors (list appended) who responded to our invitation and their ready response. May I thank the Directors of the Botanic Gardens of all countries for sending messages of good wishes.

In the preparation of this book I received in abundant measure good wishes from Dr. T.N. Khoshoo, Distinguished Scientist, CSIR and former Secretary, Department of Environment and I am grateful to him. I offer my sincere thanks to Prof. Arun Kumar Sharma and Prof. H.Y. Mohan Ram, the past and present Chairman of the Programme Advisory Committee for their helpful suggestions and sustained interest. It is my pleasure to record my thanks to Prof. (Mrs.) Archana Sharma, Professor of Genetics, University of Calcutta and President of the Indian Science Congress Association 1987 for her interest and active support. In this connection I am extremely grateful to Dr. (Mrs.) Manju Sharma, Chief (Science) Planning Commission for her personal interest in the development of Botanical Survey of India and over a decade she has been a pillar of strength to us. I thank the Director, Royal Botanic Gardens, Kew for using the photos of Col. Robert Kyd and William Roxburgh.

A word of special thanks are due to my colleagues: Dr. K. Prothathri, Joint Director for all help; Dr. V.S. Agarwal, Editor of Publications and Shri S.C. Pal, Publication Officer who helped me in great measure in bringing out the publication as per my time schedule, Shri G.S. Giri, Scientist 'B' for helping me to sorting out the papers; Shri Dulal Chandra Chakravorty, Stenographer who helped me in meticulously typing the manuscript.

Last but not the least, I am thankful to Shri Nirad Baran Mukherjee and Shri Sudhir Chandra Mukherjee, Directors of The Radiant Process Pvt. Ltd. and their staff for printing this book.

CONTENTS

NETWORK OF ARBORETA — TREE CULTURE — TREES, WOODEN DINOSAURS OF OUR AGE

M. P. NAYAR

Botanical Survey of India, Calcutta

We can marvel at the Redwoods (*Sequoia sempervirens*) of California which grow to a height of 110 metres with cathedral like columns and we can understand that some of these trees were a thousand years old when Budora attained nirvana or Jesus Nazereth preached on the banks of Dead Sea. No wonder Wordsworth felt happy at a simple Pine tree of Monte Mario, saved from the hands of axeman

Nature Poet Wordsworth wrote the following lines "about the rescued Pine tree" of Monte Mario in the early 19th century

"But when I learned the tree was living there
Saved from the sordid axe by Beaumont's care
Oh ! what a gush of tenderness was mine"

Since these lines were written, millions of trees were cut down unlamented and millions of hectares of virgin forests were leveled up for man's increasing requirements.

Man has inhabited the earth since the Pleistocene and it is a long relationship of exploitation of plants for his primary needs of food and shelter etc. In his greed for material affluence, he is engaged in an orgy of destruction of the primary forests of the world, that is, he is in the process of killing the legendary goose that lays the golden egg. Rightly, R F. Fosberg, the well known Ecologist of Smithsonian Institution cautioned Homo-sapiens as follows

"Man perhaps is playing the role of a pioneer organism .... The population curve of pioneer organism is very well known after the exponential increase, there is usually a catastrophic decrease or crash"

It is well known, plants alone have the capacity of converting the inorganic material into the organic carbohydrate through photosynthesis with the help of chloroplasts. There are about 425,000 species of living plants in the plant kingdom from the unicelular algae to the highly evolved flowering plants. The advent of flowering plants in the lower cretaceous period is the result of plant evolution in synchronisation with the insect life. This group of flowering plants (about 250,000 spp.) have developed great plasticity for adaptation in different climatic regimes and they consist of a variety of life forms from the minute *Wolffia* (0.5 to 1 millimetre long), to the largest *Eucalyptus regnans* growing to a height of about 100 metres. This spectrum of flowering plants, includes humble herbaceous species, beautiful orchids, parasitic *Rafflessia arnoldi*, having largest flowers, plants of medicinal importance and trees of commercial value. In this spectrum, parasitic, saprophytic and carnivorous plants find their ecological niche for their survival. Trees of the forests stand out as the most important constituent in this mosaic of plant communities, as

trees provide the microhabitat or niche for different small groups of plants, insects, ants and birds. Out of 250,000 species of flowering plants, it is estimated that there are about 37,500 tree species in the world, roughly 14 percent of the world's flowering plants. These trees species are considered as the most vulnerable group due to man's greed.

Trees represent nature's evolutionary effort of 4500 million years and it is a long story of organisation and development from a unicellular state to a multicellular organism with differentiation of form and functions. Finally, trees achieve their growth forms and leaf canopy with orientation of leaves lined with palisades of chloroplast for intercepting solar energy required for photosynthesis. According to the theory of endosymbiosis (Whatley et al, 1979), in a primeavel world of a bygone age, a primitive eukaryote successively took up bacteria and blue green algae to yield mitochondria and chloroplasts respectively. The one that retained aerobic bacteria in endosymbiotic relationships developed into an animal cell and one that retained blue green prokaryote alga developed into plant cell. This integration into the host cell, a prokaryote alga or anaerobic bacteria biochemically, structurally and genetically was an event of great significance in the diversification of plant and animal cells. Thus it is seen that aerobic bacteria is considered as possible ancestors of

Mausame Sacred Forest in Meghalaya

mitochondria in an animal cell and prokaryote algae as possible ancestors of chloroplasts in a plant cell. The importance of these chloroplasts can be understood if we evaluate the stored biomass in plant kingdom. Hall (1979) estimated that the world's annual use of energy is only 1/10 of the annual photosynthetic energy and the renewable biomass of the earth at present is equivalent to the total proven fossil fuels of the earth. This estimate shows that plants contribute annually energy stored biomass ten times the world's annual use of energy.

In India, out of 328 million hectares of land, about 75 million hectares are under forest ownership which includes primary and secondary forest, forest grasslands and degraded forests. This represents about 22.7 of the total land surface. During one quarter of century of developmental activities from 1951 to 1976 (according to Dr. M. S. Swaminathan, former Member, Science, Planning Commission; in a Convocation address at the Southern Forest Rangers Colleges, Coimbatore on 29th Oct. 1979) about 4.14 million hectares of forest lands have been deforested for hydroelectric, irrigation and agricultural projects and urban land systems. According to B. B. Vohra (1980), former Chairman of the National Committee of Environmental Planning and Coordination, only about 35 million hectares out of 83 million hectares described as permanent pastures and

Mangrove forest in Andamans

forests are actually under good forest cover or grass. Out of 35 million hectares of which form good forests and this includes both primary and secondary forests. In this about 23 million hectares of forest lands are ecologically disturbed with the interference of man and can best be considered as secondary forests. In India the primeaval primary forests occur only in about 7 million hectares occurring mainly in the North eastern Himalayas and mountain chains bordering Burma and few pockets in southern W.Ghats. The forest cover dwindled to 1/10 of the Indian land area due to the above mentioned causes.

In the year 2000 A.D., the population of our country would reach more than 1000 million considering the present population of 666 million in 1980. Accepting the same momentum of developmental activities in relation to the population growth, it can be computed, there will be a further loss of about 9 million hectares of forest lands due to social pressures by the year 2000 A.D. inspite of the constraints and checks appropriately taken by Environmental agencies for the prevention of conversion of forest lands. This leaves us only to a small area of 21 million hectares of primary and secondary forests in the

Nymphaea rubra Roxb. ex Andrew — Water lilies

year 2000 A.D. with components of 5 million hectares of primaeval forests and 16 million hectares of secondary forests.

The author in a paper on "Changing patterns of Indian Flora" (Nayar 1977) has estimated that India is possessing only 6% of the known flowering plants of the world i.e. only 15000 species out of 2,50,000 species in the world. Out of the 15000 species of flowering plants, it is estimated there are only about 2500 tree species which represent only 17 percent of the flowering plant species in India. In any tropical/temperate woodland ecosystem, trees constitute an important element and under their canopy, hundreds of organisms from beautiful epiphytic orchids to pathogenic fungi establish their microhabitat. Besides, thousands of soil micro-organisms depend on the humus and litter under the canopy of trees. In a closely interlinked food web, microorganisms caterpillers, birds and mamals find their ecological niche in the woodland ecosystem. Depletion or loss of trees in such an ecosystem may trigger off a chain reaction resulting in the loss or migration of hundreds of dependent animal and plant species. Hence, the author (Nayar, 1977) stated if trees in our forests are protected by men, rare herbs and shrubs get ready protection under their canopy. It is also seen that tropical trees have limited seed dispersal range, poor seed viability and they require their own ecosystem for

Swift flowing rivers in Eastern Himalayas with vegetation cover

growth. Barring a few, many tropical tree species are relicts of a bygone age and have not shown genetic dynamism for survival as the present loss of habitat and over-exploitation of forests is on a scale and momentum so vast that tree species could not survive these onslaughts.

Some of the tree species that are under threat come under the palaeotropic families which are appropriately called as "living fossils" by Soviet Botanist Takhtajan in his book "Flowering plants, origin and dispersal" (1969). Such families occurring in India are: Magnoliaceae, Annonaceae, Myristicaceae, Lauraceae and Tetracentraceae. It is mentioned in the IUCN's Threatened Plants Red Data Book, about 10 percent of the world's total flowering plants come under the dangerously rare category. In India, it is estimated that about 2000 species will become rare or threatened by the year 2000 A.D. Peter H. Raven, Director of Missouri Botanic Garden, estimates that a disappearing plant species can take with it 10 to 30 dependent species such as insects, higher animals and even other plants.

The importance of plants for the maintenance of oxygen and carbondioxide ratio in the atmosphere is well known. Plants absorb about twenty-thousand million tons of CO_2 a year through photosynthesis and in this set up, forests are one of the largest contributor of CO_2 absorption sinks

Thick stands of coniferous trees

comparing to agricultural crops. It is generally accepted that the global CO_2 budget is very important for the maintenance of earth's temperature. The two large CO_2 sinks are oceans and forests of the world. Higher CO_2 content in the atmosphere due to fuel burning resulting into the ineffective photosynthetic absorption of CO_2 from the atmosphere, may lead to higher build up of CO_2 p.p.m. in the atmosphere (Gribbin, 1978). At present CO_2 concentration is 330 p.p.m. and it is believed this would be doubled before the middle of the next century i.e. 660 p.p.m. by 2050 A.D. This means, there would be a uniform rise in world temperature, as higher concentration of CO_2 prevents heat loss. It is surmised that this "green house effect" might result in the melting of Polar Ice Caps. Due to the rise in water level of oceans, it is feared many coastal settlements would be submerged. All this could be prevented if there are good forests which can function as effective CO_2 sinks and if we can follow methods for minimum burning of fuels.

History tells that the rise and fall of civilizations are partly due to man's ignorance of tree culture and tree ecosystem. Wanton destruction of trees for fuel, monoculturing of crops, and introduction of domestic stock on patchy vegetations are the main causative factors resulting in the inexorable advance of aridity in areas where there was greenary and settlements. In such circumstances it is no coincidence that the civilizations of Harappa and Mohenjadaro disappeared under the sands of Thar Desert. The ancient Babylonian and Mesopotamian civilizations situated on the rivers Euphrates and Tigris are now largely deserts. The Mongolian and Chinese civilizations of Peking are partly engulfed by the Mongolian and Gobi deserts, while early Egyptian settlements and pyramids of Pharos are now fully engulfed by the Sahara Desert. In the new world, the Mexico desert adjacent to Mayan culture and Atacama desert in Peru near the Incas and Aztacs civilization speak volumes of the man's ignorance of plant ecosystems.

In our times during the seventies and eighties the tragedies of Sahel in Africa and Ethiopia are partly due to the unprecedented drought and partly to human factors, like deforestation for fuel and intensive browzing of pastures by cattle. The forests of Lebanon which once supplied timber to the civilizations of Mesopotamia and Egypt are now barren and denuded of trees. E. P. Eckholm in his book, i.e. "Losing Ground" (1976) mentions that the folds of Himalayas are crumbling down because of faulty agricultural practices and denudation of trees. Hundreds and thousands of cubic metres of silt and top soil of the slopes of Himalayas are being washed down the Himalayas into the river systems of India and Bangladesh, choking our canals and reservoirs in an unprecedented scale, and causing floods and loss of property worth crores of rupees every year. History tells us again that how the Greeks wisely changed their age old grain-growing and stock-raising practices in favour of tree culture. When Greece was at the height of its civilization during the pre-biblical times, Plato lamented in the *Critias* about loss of forests in Greece as follows: "..... compared with what existed then, is like the bones of a body, wasted with disease ! the fertile soil has fallen away, leaving only the skeleton of the land" But the ancient Greeks to their glory, instead of running away from their denuded lands, wisely changed their age-old agro-husbandry and adopted arboriculture, olive tree plantations and vine cultivation. The ecological cultivation of arboriculture and agro-sylviculture in difficult hilly terrains is the only solution for a stable land-use. Such a system is seen partly in the agro-sylviculture practices

in Kerala and Sri Lanka where Jack-fruit trees, Bread fruit trees, Coconut palms, Areca palms and Caryota palms are cultivated in the hilly slopes. Commercial plantations of crops which suits the ecological regimes of the mountains of Kerala, like rubber, cocoa, pepper and betel in three tier systems with tapioca in the opening and rice in the valleys are successful as this mosaic of plant crops emulate the tropical ecosystem of canopies, climbers and undergrowths. The Himalayan hills with their different climatic regimes require this mosaic of agro-sylviculture simulating its natural ecosystems. Useful arboriculture which gives in return food, timber and fixation of soil in the slopes is a matter of urgent need for the Himalayas.

If trees are to be saved and nurtured we have to heed the message of Buddha which enjoins that one should at least plant one tree every four years and tend it until it was established. According to E.F. Schumacher (1973) in his book "Small is beautiful" that much of the economic decay of south-east Asia (as of many other parts of the world), is undoubtedly due to the heedless and shameful neglect of trees. Unless action oriented plans are drawn up in inculcating the children of the formative age group the message of Buddha on the ethics and metaphysics of tree planting, all our efforts of saving our trees will be a cry in the wilderness. This is required because the present generation of youths is brought up in the ethics of materialism

A denuded mountain system with gully erosion

since the present economic theory is based on the premises, quoting Schumacher that "an activity can be economic, although it plays hell with the environment and that a competing activity, if at some cost it protects and conserves the environment will be uneconomic"

In order to destroy the Vale of Sharon in Palestine, where apple orchards and Vineyards produced luscious fruits, an envy of the East, Crusaders and Arab invaders during the middle centuries, vied with each other in destroying these orchards. During the period of Ottaman empire, to keep the people of Sharon under subjugation under the Turks, a heavy tax was imposed on every tree. In order to avoid tax, the natives *fellaheen* cut down their own trees. If we can observe the same materialistic principle in reverse — a tax rebate is given for every orchard of trees nurtured in the backyards, wastelands of India leased out to people, there will be a great resurgence of tree planting activities which can indirectly bring in great prosperity to the nation. If we can adopt the Code of Buddha the present generation need not lament over the environment as Wordsworth did in "Guilt & Sorrow"

"No tree was there, no meadows pleasant green,
No brook to wet his lip, or soothe his ear"

CIVILIZATION AND GENE POOL CENTRES

Man passed from barbarism to civilization by domestication of plants and animals and by so doing he himself got domesticated. Vavilov's gene pool centres can be readily traced to the cradles of ancient civilizations. The great centres of civilizations originated in the river valleys. The great Chinese civilization originated in the Yellow river, the Indus valley civilizations in the Indus valley, the Mesopotamian civilization in the valleys Tigris and Euphrates etc. By artificial selection of cultivated plants Man adapted new species suitable to particular environment. Though he had a vast assemblage of gene material it is probable that by the process of selection and weeding out the seemingly unproductive and unsuitable plants Man might have destroyed vast assemblage of germplasm. It is interesting to see that all along these cradles of ancient civilization there are varying desert regions. Besides other contributing factors these deserts are partly man-made. It could be argued that the fall of many civilizations is due to the lack of knowledge of his ecosystem and his dependence on few high yielding varieties to the suicidal exclusion of other species. As Sir John Boyd Orr former Director General of FAO said that "A civilization which cannot find food for its people is one which cannot endure" Today thanks to Green revolution to a large extent we have self sufficiency in food. But their genetic base is slowly getting eroded due to loss of our wild plants.

ROLE OF BOTANIC GARDENS

We are all familiar with the fact that most of the economic plants were originally introduced and distributed to the other parts of the World through Botanic Gardens and Arboreta. The existing pattern of the World Crops has come out of the progressive introduction and dispersal over the centuries, plant species of economic importance (Heywood, 1985) into new areas. In India the foreign exchange earning rubber and cashew plants from Brazil and tea from NE India are notable examples of plant introductions through Gardens. Floriculturists of the World are indebted to Sir Joseph Hooker for the introduction of giant Rhododendrons from the Himalayas in 1877 and to Francis Masson for the Geraniums from South Africa. Though these are great events, Botanic

Gardens should take interest in the preservation of at least plants growing in the nearest endemic centres and exchange freely all rare and endangered species.

THE BOTANIC GARDENS OF INDIA AS A CHAIN OF GARDENS FOR CONSERVATION PURPOSES

Heywood (1985) graphically described the present plight of the Botanic Gardens, all over the world. "In the twentieth century with the creation of separate agricultural institutions and research stations, botanic gardens lost their link with agriculture and went through a phase of uncertainty and decline. With the rise of experimental botany, the role of taxonomy declined and efforts were concentrated on evolutionary or bio-systematic largely non-classificatory aspects to the neglect of the informations processing role of the subject".

Most of the Botanic Gardens established during the times of early periods of Indian history by Kings & Maharajas and during British regime are now attached to the Horticultural departments of State Governments except the well known Indian Botanic Garden. There is awareness that this state of affairs is to be remedied. There are new schemes mooted for the establishment of the National Botanic Garden at Delhi and funded gardens for conservation purposes through "Model Botanic Gardens". Though resource constraints are coming in the way, the awareness

Clean felling of forest cover

of the necessity to establish chain of botanic gardens is largely felt among people, scientists and administrators.

In India the Botanical Survey of India maintains Indian Botanic Garden which is going to celebrate its bicentenary in 1987. The garden was established in 1787 by Col. Robert Kyd. The well known lineage of botanists from Roxburgh, Buchanan-Hamilton, Wallich, Griffith, King, Gage, Biswas made valuable contributions to the enrichment of this garden. The garden spreads over an area of 110 hectares with 1.5 km. of river front of the west bank of the river Hooghly and is broadly divided into 25 divisions which grow plants of specific geographical regions. About 15,000 trees and shrubs are under cultivation comprising about 2500 species. But among all the trees the Great Banyan tree attracts millions of visitors every year. This Banyan tree is over 230 years old with about 1825 prop roots and spreads over the area of 3.46 acres. The Giant Water Lilies (*Victoria amazonica, V. cruziana*) with their massive floating leaves are great attractants for visitors during June to September. The screwpine collections, bamboo collections and palm collections are one of the best in the world

The other Gardens of the Botanical Survey of India are the National Orchidaria at Shillong and Yercaud. There are also experimental gardens at Barapani, the National Gymnosperm sanctuary at Pauri (U.P.), the Experimental gardens at Pune,

Dried up soil forming fissures.

Allahabad, Port Blair and Itanagar. The other important gardens are the Lloyd Botanic Garden, Darjeeling (Estb. 1878), Lalbagh Garden, Bangalore (Estb. 1878), Sim's Park Coonar (Estb. 1874), Botanical Garden of the Forest Research Institute Dehra Dun (Estb. 1934), Botanical Garden of the National Botanical Research Institute, Lucknow (Estb. 1953), Government Botanic Garden, Ootacamund (Estb. 1847), Tropical Botanic Garden, Trivandrum (Estb. 1979)

Important public parks which serve the community are, the Government Botanic Garden, Trivandrum; Shri Chamarajendra Park, Bangalore; The Agri-Horticultural Society of India, Calcutta; Padmaja Naidu Himalayan Zoological Park, Darjeeling; Jubilee Park, Jamshedpur; Mandore Garden, Jodhpur; Nehru Park, Jodhpur; Shalimar Garden, Srinagar; Nishat Garden, Srinagar; The Agri-Horticultural Society, Madras; Cuizon Park, Mysore; The Buddha Jayanti Park, New Delhi; The Mughal Garden, Pinjore; The Rashtrapathi Bhavan Gardens, New Delhi; Gandhi Park, Sironj; Orchid Sanctuary, Gangtok. There are large and small gardens attached to river valley projects and dams and Botany Departments of Agricultural Universities.

The main aim of the Botanical Survey of India in the coming decade is to make a thrust in this area so that a net work of gardens are developed in India through exchange of plant material. R. K. Chakraverty and D.P. Mukopadhya (in edition) of the Botanical Survey of India is publishing a book on the Directory of Botanic Gardens under the auspices of the Botanical Survey of India.

Again quoting the words of Kenton Miller (1985), Director General, IUCN, that "The Botanic Gardens of the World could and should develop into a major new global force for conservation" This network is an humble attempt towards this direction.

REFERENCES : Gribbin John, Carbon dioxide and climate. Energy Policy 6:4:, 314-319 1978

Hall, D.O. Fortunately for us plants are very adaptable Nature 278 114-117, 1979.

Heywood V.H. Botanic Gardens and Taxonomy Bull Bot Surv India 25:1-4: 134-147, 1983 (1985)

Miller Kenton R. Introduction Botanic Gardens and the world conservation strategy Las Palmas 1985

Nayar, M.P. Changing patterns of the Indian flora Bull Bot Surv India 19 145-155 1977

Vohra B.B. Ministry for land and water Sardar Patel Memorial Lectures 1980 Dept of Environment, Govt of India 1-28 1980

Whatley J.M., John, P. and Whatley F.R. From Extracellular to Intracellular, the establishment of mitochondria and chloroplasts Proc R Soc Lond B 204 165-187 1979

THE BOTANIC GARDENS OF ADELAIDE

BRIAN MORLEY

Botanic Gardens of Adelaide, North Terrace, Adelaide, S.A. 5000

South Australia was proclaimed in December 1836, and in 1837 Col. Light in his plan of Adelaide had shown an area set aside for a Botanic Garden. He showed a site on an island in the River Torrens, but this unfortunately flooded in wet weather and had to be abandoned. A second site was chosen, also in 1837, but little is known about this area other than that it was eventually leased to Thomas Allen who grew fruit and vegetables there. It seems that it became unsatisfactory as a botanic garden because stock from the Parklands, also part of Col. Light's plan, regularly invaded the area. The third attempt in 1839 was more successful and involved a man called John Bailey who was appointed to prepare land on the north bank of the River Torrens opposite the present site of the Adelaide Zoo. The garden was planted, but financial difficulties in the colony at that stage forced the closure of the garden and Bailey was made redundant.

It was not until 1854 that the Agricultural and Horticultural Society recommended the establishment of a 18.5 ha (47 acres) Botanic Garden on the present site. In April 1855 George Francis was appointed Superintendent and the Garden was opened to the public in 1857. In planning the Garden, Francis is said to have been influenced by those at Kew and Versailles together with certain German and Dutch stylistic influences; even today the Botanic Garden in Adelaide has a northern European style of landscape also reflected by certain of the buildings.

From an early date in the Botanic Garden there was a close relationship between botanical and zoological exhibits. By 1881 the number of animal cages in the Botanic Gardens had risen to about 200 and there were some 553 animals and birds exhibited. These were soon after transferred to the newly formed Zoological Gardens adjacent to the Botanic Garden where they still reside.

In 1865 George Francis resigned owing to ill health and Dr Richard Schomburgk was appointed his successor, a position which Schomburgk held until his death in 1891. Under the Schomburgk administration the Garden continued to flourish even though the basic features were established in Francis' administration. We understand that the plant collection increased numerically from about 5000 to 14,000 species, although figures such as these are sometimes not as accurate as one would wish. Detailed development of particular areas of the Garden took place.

Many trees were planted during Schomburgk's administration and many of the plantings from this time are still extant, for example the Moreton Bay Fig Avenue was planted in 1866; the Plane Avenue Drive in Botanic Park was planted in 1874. Botanic Park was dedicated in 1894, but the 84 acres of land, acquired in 1866, had been used for grazing Police horses. Since that time Botanic Park has been closely associated with the Botanic Garden, and plans for the future will

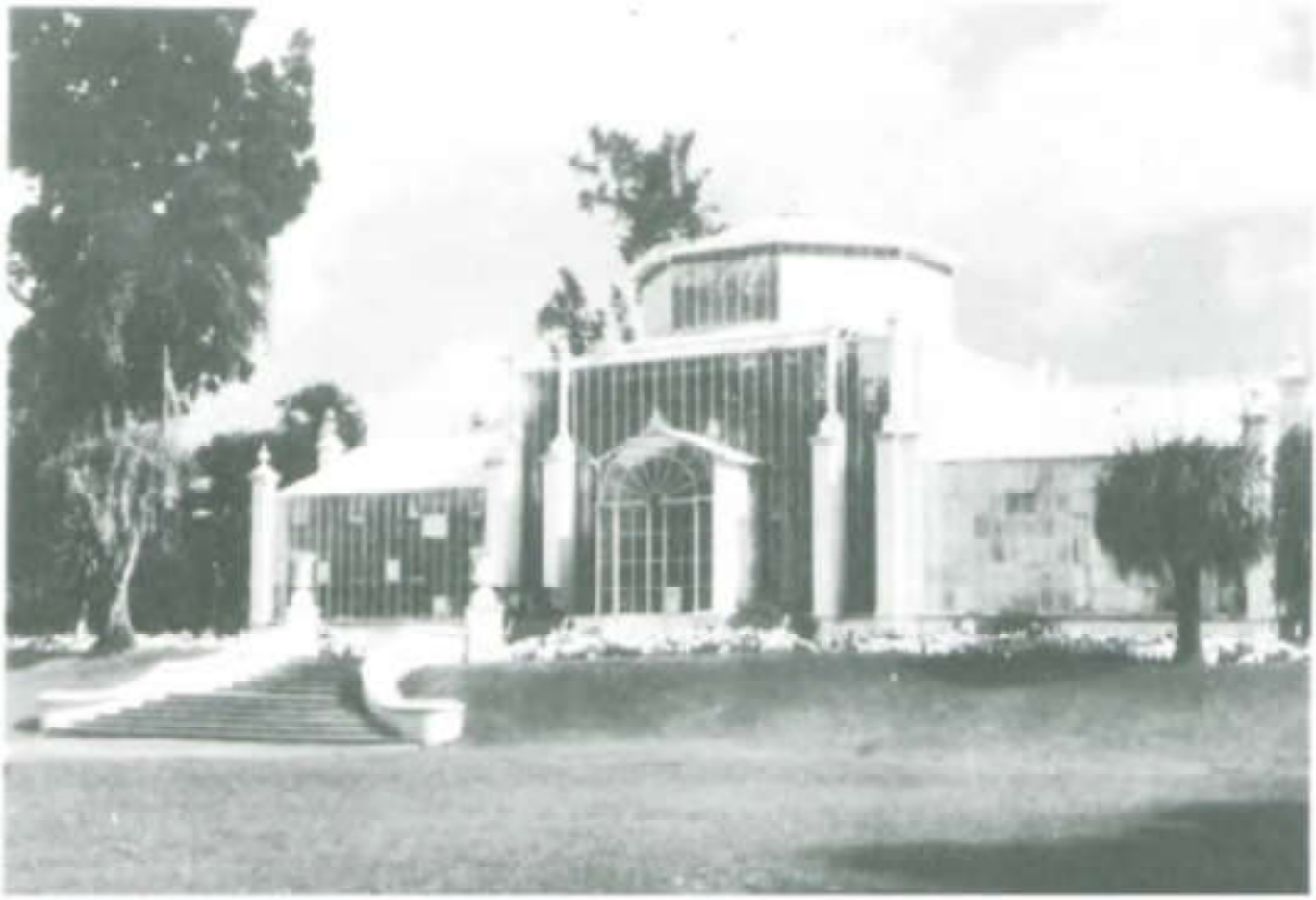
continue this tradition. It was in Botanic Park that the Salvation Army held its first meeting in Australasia, and the Centenary of this meeting was held in the Park in 1980 when an additional avenue of Plane Trees was planted in commemoration.

But as well as plantings in the Botanic Garden, buildings had been constructed. In 1868 the Victoria water lily, *Victoria amazonica,* discovered in northern South America by a brother of Schomburgk, was flowered in the Victoria House, producing its leaves up to almost a metre in diameter, and arousing great public interest as seen in the newspapers of the day. Since that time cultivation and flowering of *Victoria amazonica* has been associated with the Adelaide Botanic Garden in Australia.

Another significant building about this time was the Palm House, or as we call it today the Tropical House, which was imported from Germany and opened to the public in 1877. At that time it was situated on a grass mound which is presently partly occupied by the cacti and succulent collection. It is one of the finest Victorian glasshouses in Australia and is listed on the National Estate. It was imported in a pre-fabricated state and when unpacked at Port Adelaide, all the glass was found to be broken and a new consignment had to be imported from Germany. The design of the house is Germanic, charmingly fussy and typical of the mid-Victorian period.

In 1881, another significant building in the Adelaide Botanic Garden was opened to the public: the Museum of Economic Botany. This was built in the Attic architectural style. It is the first example of this style in the colony and with its beautiful stencil painted ceiling inside, is listed on the National Estate. The exhibits are presently being restaged in period style.

Tropical House, Adelaide Botanic Garden



More significantly the building represents the only Museum of Economic Botany in any botanic garden in Australia. Like Kew, and other botanic gardens around the world, the provision of a Museum of Economic Botany in a botanic garden is typical of the type of public institution set up in the Victorian period.

The fine cast iron Main Gates on North Terrace were erected in 1880 and provided a fitting entrance to the, by now, well established and patronised Botanic Garden. These gates are listed on the National Estate and were originally imported from England.

During the Schomburgk era, the Garden not only fulfilled recreational and educational functions but also had agronomic importance· economic crops were introduced such as strains of wheat, oats and sorghum; fruit and vines were tested and if considered suitable were distributed to growers and the public. Much of the work of Australian botanic gardens was as plant acclimatisation centres not only in South Australia, but in New South Wales, Victoria, and elsewhere, such as India.

Main Gates, Adelaide Botanic Garden

Schomburgk exchanged both seeds and herbarium specimens of the State's flora with colleagues and scientists overseas. His predecessor, Francis, was an Englishman while Schomburgk was German and it is interesting that at Adelaide a somewhat similar situation existed to that at the Royal Botanic Gardens, Melbourne, where Guilfoyle an Englishman and Ferdinand von Mueller a German were both influential early directors. Although posterity will judge, it is probably true to say that the next most significant Director at the Adelaide Botanic Garden was the recently retired Noel Lothian who re-established the State Herbarium in 1955, re-established a significant botanical library, radically upgraded staff accommodation facilities at the Garden, and reasserted the standard of service which one expects from a Botanic Garden. It was also in his administration that a gardener training scheme began, and the Simpson Kiosk was remodelled and renovated into one of the most attractive cafe/restaurants in any botanic garden.

For the future 5.3 ha will be added to the eastern side of the garden by the progressive withdrawal and relocation of a bus depot. The new area will be used to expand ornamental scientific and educational displays for the public, provide a site for a large tropical conservatory to be built as the major A$5.48 million metropolitan Bicentennial project for South Australia in 1988, and allow radical landscape improvements to the eastern frontage of the botanic garden.

It was Lothian's vision that brought about the acquisition of the Mount Lofty Botanic Garden which presently occupies about 100 ha in the Mount Lofty Ranges. The rationale behind the development of this garden was that it represented a completely different garden climate to that available on the Adelaide plains. Early in the Lothian administration, in 1948, the Board of Governors of the Botanic Garden accepted a recommendation that an area of land within the high rainfall region of the State should be acquired for the development of a satellite botanic garden. The first purchase of land took place in 1952 and between that date and 1977, when the Garden was first opened to the public, plantings of northern and southern hemisphere temperate plants were progressively made in the seven valleys which intersect this area of essentially Stringy Bark *(Eucalyptus obliqua)* adjacent to the Mount Lofty Summit.

Each of the valley of the seven creeks has been devoted to the cultivation of particular groups of plants. Thus Second Creek has been used for the cultivation of an extensive collection of *Syringa*. Third Creek is used for the cultivation of *Rhododendron*, azaleas and plants from the Himalaya and China. Fourth Creek has been used for the cultivation of *Viburnum, philadelphus;* and Sixth Creek has been used to develop the Fern Gully. Seventh Creek has been used to establish a collection of *Magnolia* spp., and in this way dramatic plantings are being developed for posterity. All of the creeks converge on two man made lakes on the shores of which are collections of conifers, *Pyrus* and Prunus.

It is envisaged that development will take another 30 years. A modern nursery serves the Botanic Garden at Mount Lofty, as do two car parks — one at a high level with an adjacent viewing platform with an extensive panorama extending to the Barossa Ranges and Murray Malle; a lower car park gives access to lower parts of the Garden. There are also two flora reserves associated with the Botanic Garden which will be open to the public in the future.

The third of the three Botanic Gardens of Adelaide, Wittunga (15.4 ha), is situated half way between Mount Lofty Botanic Garden in the hills and Adelaide Botanic Garden on the plain. In this way, the Botanic Gardens in metropolitan Adelaide can be used to grow a range of plants which vary from, on the plains, sub-tropical and tropical — bananas can be ripened — to arctic alpine plants at Mount Lofty. There is a remarkable spectrum of growing conditions for plants which is very

View to lake, Wittunga Botanic Garden

desirable for an effective botanic garden system.

Wittunga was established by Mr Edwin Ashby in the spring of 1902, at Blackwood, and the nucleus was a formal English garden, herbaceous border trellis and arbours. But Mr Ashby became more and more fascinated with the native flora and began to specialise in their cultivation and experimented at some length with methods of propagation and systems of watering these plants. As well as the Australian natives which Ashby cultivated, he also built up a large collection; and forged significant connections with the students of plants of the South African flora, particularly in relation to species of *Erica* and *Protea*.

Following Edwin Ashby's death in 1941, the garden passed to his son, Mr Keith Ashby, who inherited his father's enthusiasm and love for both Australian and South African plants. It was the collection of ericas and proteas at Wittunga, as well as the residence, which was subsequently handed over to the State under the responsibility of the Board of the Botanic Gardens in 1965. It was not until 1975, however, that the garden was formally opened to the public.

It would probably give Keith Ashby great pleasure to see how much more development has taken place at Wittunga since his death in 1971. The garden is now a mecca for students and lovers of Australian and South African flowering plants. The ericas and proteas in spring are a spectacle to behold and Wittunga is reputed to have one of the best *Erica* collections in the world, on the advice of a well known South African authority. There are two small lakes associated with the garden, the garden being divided into an older part which preserves the design created by the Ashby family, and the newer part into which more extensive *Erica* and *Protea* plantings have been made. As well as this, plans exist for a bog garden. A small nursery provides all the necessary facilities for propagation and maintenance of these collections. Many of the South African plants have never been introduced to Australia and Wittunga, Mount Lofty and Adelaide Botanic Gardens, continue to provide a useful introduction centre for new ornamental plants for people in South Australia and throughout Australia.

The Adelaide Botanic Garden is the administrative headquarters for the three Botanic Gardens and also coordinates the work required for maintenance of Government House grounds on North Terrace, which is another responsibility of the Board. The care and maintenance of the heritage garden of about 4 ha at Stirling, known as "Beechwood" was made the responsibility of the Board in May 1981. Beechwood is a fine example of a late Victorian *Rhododendron* pleasure garden in the English manner. It includes an elegant recently restored curvilinear conservatory and involves the Board in historic garden conservation. The garden is listed on the National Estate Inventory.

Seven experimental plantations are maintained in various parts of South Australia at Giles Corner, Lameroo, Stansbury, Cleve, Hawker, Quorn and Mt Gambier, in conjunction with local land holders or local government. Native and exotic trees and shrubs are cultivated under a natural rainfall regime and the performance of the different species is monitored. The results of these experiments are helping to select the best sorts of species for use in civic and other plantings in semi arid situations.

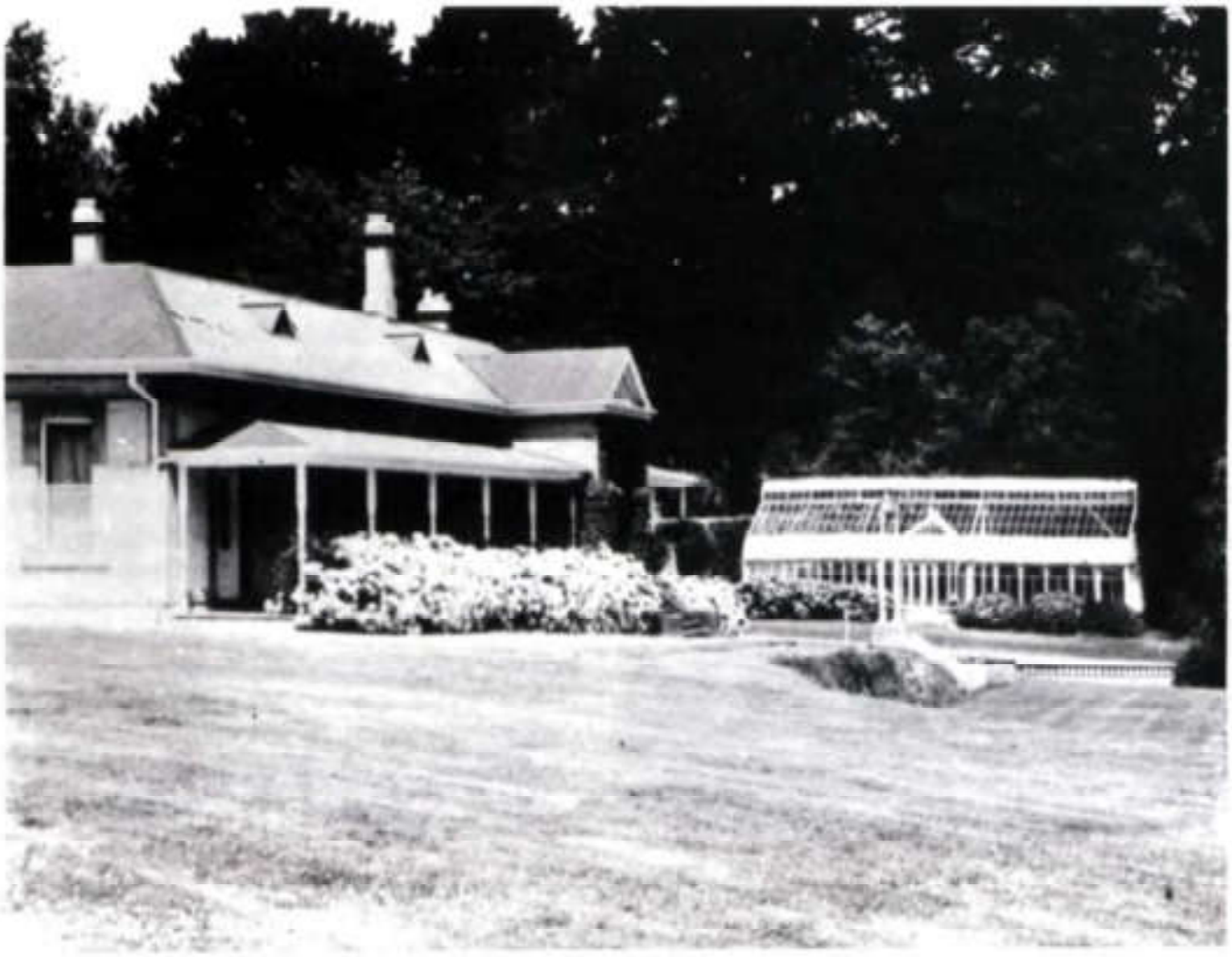
In conjunction with the Port Augusta City Council and community groups, the Botanic Gardens of Adelaide has, in the

past three years, been supporting the concept of development of an Arid Land Botanic Garden at Port Augusta. This is the first of its kind in Australia and will be used to promote a better understanding of arid land plants from all parts of the world, but with particular emphasis on Australiâ. The proposal is supported by the Royal Australian Institute of Parks and Recreation.

At the Adelaide Botanic Garden are situated two important community services. The State Herbarium is the repository for all the dried specimens of the native flora of South Australia and is also the centre in which taxonomic work and research pertaining to the State flora takes place. It is where the new edition of the 'Flora of South Australia' is being written, but is also where a great deal of work on taxonomy and nomenclature of native plants from all over Australia takes place. The State Herbarium like its sister institutions in Sydney, Melbourne, Canberra, Brisbane and Perth, is part of a network of botanical institutions servicing the botanical needs of the country; it has a highly qualified staff and has one of the best publishing records of any herbarium in the southern hemisphere.

Considerable taxonomic expertise exists in the State Herbarium. Dr R. Chinnock is an authority on Myoporaceae; Dr H. Toelken an authority on *Crassula*; Dr W. Barker an authority on Australian Scrophulariaceae; Dr A. Munir an authority on Verbenaceae and Chloanthaceae. Mr J. Weber is an authority on *Cassytha* and

Residence and conservatory, Beechwood Heritage Garden



S. Australian Orchidaceae. Dr J. P. Jessop is an authority on Liliaceae and editor-in-chief of the 'Flora of South Australia' and 'Flora of Central Australia' projects, as well as being the head of the State Herbarium. The important Cleland Mycological Herbarium is situated in the State Herbarium, as are the collections previously housed in the Waite Agricultural Research Institute and including the rich Solanaceae collections of D. Symon.

The Board of the Botanic Gardens publishes the *Journal of Adelaide Botanic Gardens* on an occasional basis. It also publishes a handbook series of a more popular nature, the most recent titles being Tree Culture, and Sansevierias as well as more ephemeral brochures. The staff collaborate with the South Australian Handbooks Committee over the publication of works on the flora of the State, one of the most recent being a work on the *Acacia* species of South Australia. Staff also work with commercial publishing houses on works such as the 'Flora of Central Australia' (1981) and 'Flowering Plants in Australia' (1983).

The record system of the living plant collections is being adapted to computers. Close liaison already exists with the I.U.C.N. Threatened Plants Committee and their data base assembled on endangered species in cultivation. The Botanic Gardens of Adelaide is not responsible for protected plants legislation in South Australia, nor directly involved in studies on the status of endangered species: this work is carried out by the National Parks and Wildlife Service and officers in the Department of Environment and Planning.

An acquisition policy exists whereby whenever possible for living material to be obtained from known provenance. An index seminum is circulated to more than 500 overseas institutions, the seed chiefly comprising species from wild S. Australian localities. Seed is kept in dry, non-refrigerated storage, and is regularly tested for viability under controlled conditions in growth cabinets.

The other major community service which involves staff in a great deal of time is the advisory service to the general public. Some 20,000 enquiries are received each year by telephone, by visits or by letter; the sorts of enquiries relate to problems people are having with roots in sewerage pipes, the identity of an unknown plant, the problems associated with growing a particular ornamental plant in the Adelaide climate, or pests and diseases on ornamental plants. There is a full time advisory service, and a plant pathologist is resident on the staff. This officer can answer any pathological problem, having a fully equipped pathology laboratory. The pathologist is an accredited Quarantine Officer of the Commonwealth Quarantine Service, and the Adelaide Botanic Garden an accredited Quarantine Station and part of the Commonwealth system of quarantine stations.

A small but effective tissue culture facility is operated by the plant pathologist, partly to investigate growth media suitable for raising various ornamental plants, but mainly to assist pathology work involving disease free root stock production in conjunction with the industry, and in-vitro testing of susceptibility of fungal pathogens to new chemical sprays.

To permit closer contact with the community, the Friends of the Botanic Gardens of Adelaide was established in 1977. Membership now stands at more than 700. The Friends provide guided tours in the Adelaide Botanic Garden, operate a shop in the Adelaide Botanic Garden, as

well as producing items for sale, organising tours to places of interest and arranging regular lectures and meetings. With headquarters provided by the Board, the Friends make regular substantial donations to the Botanic Garden of items which would not be otherwise possible from the State Government financial allocation.

While the Friends carry out some of the adult education functions of the botanic garden, formal gardener apprenticeships are offered: the organisation is the largest employer of gardener apprentices in the State. At school level an Education Officer is seconded from the State Education Department and provides a resource centre for teachers as well as coordinating more than 15,000 children who visit the botanic garden in official groups. At university level the State herbarium offers unparalleled opportunity for graduate and postgraduate work, particularly in the area of taxonomy. Strong links exist with the University of Adelaide and Waite Agricultural Research Institute, and Flinders University.

The Adelaide Botanic Gardens are part of the South Australian Government. The Gardens are run by an eight member Board, of which the Director is Secretary. The Board administers the three Botanic Gardens and the two other associated gardens according to the Botanic Gardens Act, 1978. The Botanic Garden organisation is part of the Department of Environment and Planning, although the Board has management autonomy and is directly responsible to the Minister. The Botanic Gardens have 130 staff comprising 95 gardening staff and 35 technical and research staff, many of whom are graduates and post-graduates. Only with staff of this calibre is it possible for the Botanic Gardens of Adelaide to maintain the standards with which it has become associated, and for which it is well known not only within South Australia and Australia, but the botanical and horticultural community throughout the world. At the same time it is important to remember that the Botanic Gardens of Adelaide is a provincial organisation intended to serve a local community on the basis of perceived need.

REFERENCES

Jessop, J. P. (ed.) Flora of Central Australia. Reed: Sydney. 1981.

Morley, B.D. and Toelken, H.R., eds. Flowering Plants in Australia. Rigby: Adelaide. 1983.

Wilbey, R.J. Agencies of South Australian Govt. Permit: Adelaide. 1980.

THE HISTORY AND PRESENT ROLE OF PISA BOTANICAL GARDENS

F. GARBARI

Botany Department, Pisa University, Italy

The present Botanical gardens in Pisa are one of the third in this city; the first was already in function by 1544 — one year before that in Padua, instituted on 25 June 1545, commonly, but erroneously, considered to be this first, ever in Europe — proved by a letter dated 4 July, 1545, written by the founder, Luca Ghini, which speaks of a garden laid out in Pisa "for the use of students", ready prepared that year to receive plants gathered on the Appenines by the writer himself and a helper (Chiarugi, 1953; Fedeli, 1917; Martinoli, 1963)

Portrait of Giuseppe Casabona

Luca Ghini had studied under Ulisse Aldrovandi and was Professor of Medicine at Bologna when the Grand-Duke Cosimo I de'Medici of Tuscany called him to Pisa in 1543 to teach Botany. He immediately realised the necessity for a garden by which to show the students live plants, of a collection of dried plants in a "herbarium", and of accurate representations taken from life to ensure they were scientifically correct (Garbari, 1980). According to maps of the day, the first site occupied by the gardens was beside the Medici Arsenal on the right bank of the River Arno near an old monastery. At the time of Luca Ghini, famous naturalists and scientists came to visit it, but today no traces remain of its existence on the site (Tomei and Del Prete, 1983).

When the arsenal was enlarged in 1563 the Gardens had to be moved to another part of the city. The second version was the work of Andrea Cesalpino, the great scientist, botanist and doctor, all traces of this garden too, have disappeared from this second site. Between 1591 and 1592 Lorenzo Mazzanga and Giuseppe Casabona created the third, and final, University Botanical gardens in Pisa. It was built according to the *Rinascimento* fashion of the day, it soon became the centre of scientific interest and culture.

The original Institute building, built by order or Ferdinand I de'Medici, Grand

Duke of Tuscany, and his wife, is still standing today. A "gallery" for exhibits — animals, plants and nature's curiosities — was created in 1596, which eventually was to give place to a museum of Natural History.

The fine collections, high-quality drawings (Tongiorgi Tomasi, 1979), herbaria with precious samples of flora, and enlightened teachers ready to exchange views and information with their likes in other universities, made this place famous. A well-stocked library, most of which is luckily extant, is further confirmation of the culturally important role Pisa Gardens played in those years (Sbrana, 1982).

Towards the end of the 17th century — in 1685 to be exact — Michelangelo Tilli, a botanist of high repute whose work was admired by Linneus, began his office as "praefectus" of Pisa gardens. His work of fundamental importance, the *Catalogus plantarum horti pisani* was edited in 1723. A map, engraved by C. Mogalli inserted in this text shows the disposition of the beds; there is also a list of the species accompanied by some high-quality drawings showing the wealth of collections it contained.

The old Institute Building, constructed at the end of the 16th century

Other famous naturalists were to follow Michelangelo Tilli: his son, Angelo Attilio Tilli (until 1781), Giorgio Santi (1782-1814), who wrote the highly informative "Viaggi" (Travels in Tuscany), Gaetano Savi (1814-1842) known chiefly for his "Flora pisana" written in 1798 and for a "Treatise" on trees; Pietro Savi (until 1871), Teodoro Caruel (until 1880), Giovanni Arcangeli (until 1915); Biagio Longo (until 1923), and finally Alberto Chiarugi (1930-1949), who brings us to the present day.

Of the many merits of these gardens have been the introduction into Italy of alien species of shrubs and trees which are today widespread, among these are the horse chestnut, the American maple, *Ailanthus glandulosa*, *Juglans nigra* and camphor. Many ornamental varieties of rose and camelia have been selected and have spread from Pisa, some of which are still vigorous. There are majestic examples of *Ginkgo biloba*, *Cinnamomum camphora*, *Araucaria bidwilli*, *Jubaea spectabilis*, *Washingtonia filifera* among others. There are living examples of successful attempts to acclimatize alien plants which now adorn many parks and gardens in western Tuscany.

Pisa Botanical Gardens has undergone many changes since the original plan was laid out during the *Rinascimento*. It is divided into two main sectors, with the Botanical Institute building and several hothouses at its centre. To the south it borders on the Institute of Animal Biology and the new "teaching centre" housing the Faculty of Biological and Natural Sciences, which now occupies the place of a shed in which, until 1984 were exhibited a large and exceptionally interesting collection of Cetaceous skeletons. These have been transferred to the Museum of Natural and Local History in the Calci Charterhouse, ten kilometers from Pisa. Here is the so-called "School": about a hundred rectangular beds are planted with various botanical species, representative of many Angiosperm, Gymnosperm and Pteridophyte families, both native and alien. Each bed contained originally only entities from one systematic group according to the schematization and the systematic-taxonomical ideas in vogue during the late 18th century. The "School" has changed its physiognomy, partly because the venerable age and size of some of the plants no longer permits the cultivation of others under their canopies, but the collections have also been broken up for convenience or for ecological reasons.

The original building housing the Institute lies in the south-east corner of the gardens. It was built in the last decade of the 16th century and its strange facade is decorated in the "grotesque" style; it underwent partial restoration, carried out by the Superintendence for Monuments, in the winter of 1983-1984.

Opposite the facade is an ornamental gate, once the main entrance to the gardens; it too is decorated in the "grotesque" style.

An attractive corner of the garden is that along one side of the "School" — the so-called "Cedar garden". Until about fifty years ago a huge Cedar of Lebanon (*Cedrus libani*), planted by the "praefectus" (curator) Giorgio Santi in 1787 was growing here in the company of a beautiful *Magnolia grandiflora* and a *Ginkgo biloba*, both of them, too, planted in 1787. Unfortunately only the latter two survive, decayed and pollarded, the oldest living plants in the garden; sadly, the cedar was uprooted by a gale fifty years ago.

Beside the "Cedar garden" is a square patch in which a famous *Myrtus communis* var. *tarentina*, the size of a tree, has been growing since 1815, surrounded by

medicinal plants — a small version of a 16th century "garden of simples"

It is the customary haunt of students from the Faculty of Pharmacology and from the Postgraduate School of Specialization in Medicinal Plant Science and Technology. It contains valerians, mints, rhubarbs, hemlock, deadly nightshade, foxglove, celandine, mandrake and many others used in home remedies and on an industrial scale. Hundreds, of plants in pots prepared for studies in systematics and cytogenetics stand on brickwork steps under the shade of a huge American Oak (*Quercus virginiana*) planted in 1829.

The northern part of the garden — near the Leaning Tower of Pisa — has some attractive views. Here we find "Montagnola" (the hillock), a sort of rockery, and a pond full of water lilies and lotus flowers. There is an interesting grove of trees, a replica of Mediterranean woodland, with typical essences. The generally harmonious layout of the garden is somewhat altered by a small experimental plantation unfortunately placed here; on the contrary, two 19th century brick buildings, one of which is a wash-house, the other an attractive niche set into the boundary walls, embellish it.

There is a very healthy example of a camphor-tree with some very tall Australian araucarias; although the latter lost their branches during the hard winter of 1985, they have recovered and continue to grow and reproduce vigorously. To one side a thick bamboo copse (*Phyllostachys bambusoides*) there is a fine specimen of *Taxodium distichum* showing several gnarled *pneumatodia*.

As we have already said, the main buildings housing the Department, and the hothouses are placed at the centre of this three-hectare garden. Here too is the Botanical Museum, a valuable aid to school-teachers. In the main room there are the exhibits, visual aids (projectors etc.) and

The facade of the Institute, begun in 1890, and forecourt.

posters explaining a few important scientific questions, such as photosynthesis, the importance of wood in daily life, poisonous plants in Italy and so on.

FACILITIES AND MANAGEMENT

There are two hothouses for the protection of the more thermophilic plants during the winter, a small greenhouse contains tropical species and about another 1100 m² of ground are covered, these, together with couches, tanks for hydrophytes and a lemon-house are all the facilities the gardens dispose of at present; plans to improve and modernise them have not so far been approved by the University Authorities, and finances are not forthcoming; sheds for protecting machinery, changing rooms and other facilities are only just sufficient for management, research and teaching needs.

There are 12 gardeners on the permanent staff, with various levels of training, helped in the high season according to necessity by casual labour which can be taken on according to special provisions by law.

The gardens can be visited at all times, with the exception of saturdays, sundays and public holidays, free of charge. Each year about 300 classes of schoolchildren and 10.000 members of the public are shown around it by qualified guides. Visits can be arranged by letter or by a telephone-call to the person in charge of these arrangements.

The Botanical Garden was an independent Institute, part of the Faculty of Mathematical, Physical and Natural Sciences, up till 1 January 1984, but following the law on University reform passed in 1980, it and its teaching and technical staff belong to the Department of Botanical Science. Although the numbers on the technical staff remain unvaried, this new type of management has deprived the Garden of its independence, both administrative and financial. The result is a preclusion of cultural, teaching and independant research activites, which the Department is not yet able to guarantee with any permanence or certainty at present. Since the same situation has occurred again and again on a national scale, a better solution is called for; a Work Group has been formed by the Italian Botanical Society (*Societa Botanica Italiana* — the S.B.I.) and the National Association of Science Museums (*Associazione Nazionale dei Musei Scientifici* — the A.N.M.S.), to study the situation. The present writer, as Director of the Pisa Botanical Gardens and as Secretary of the S.B.I. Workgroup, is deeply committed to restoring Botanical Gardens to their former independence.

THE PRESENT ROLE OF THE PISA GARDEN

The Botanical Garden in Pisa is traditionally primarily an aid for University teaching; in addition to this, in recent years it has been attempted to improve and back up research — as many other gardens in Italy and abroad have — by growing certain types of plant, both in pots and in the open air. These include numerous officinal herbs and plants of biogeographical or karyiological interest. The garden also promotes research into problems of ecology in nearby areas — the Apuane Alps, the Tuscan-Emilian Apennines, the Pisan Hills and in the Tuscan Archipelago. Environments of special naturalistic interest in Tuscany are also an object of research. The interest and commitment in work, to save certain biotopes in damp areas and several rare relics from the quaternary glaciations, continues with determination. To guarantee the survival of some nearly extinct species from central Italy they are being cultivated in the garden, by arrangement with the Botanical Gardens in the near-by town of Lucca.

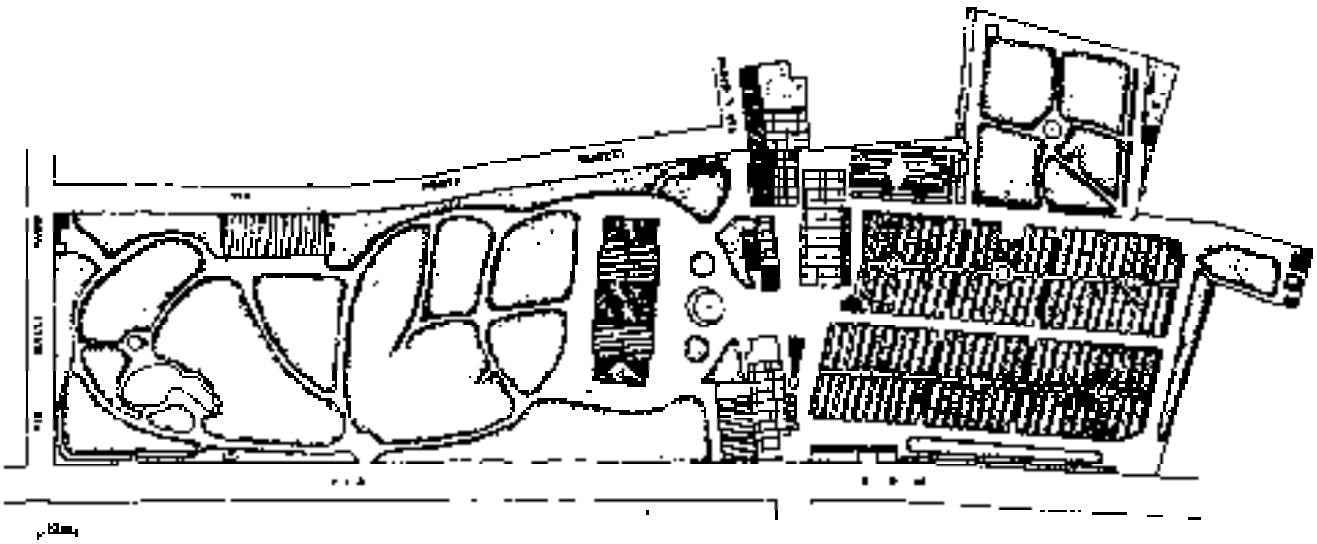
The activity of seed collecting — particularly from spontaneously growing plants — has increased, these will be exchanged with 400 other gardens all over the world. The *exsiccata* collection in the *Herbarium Horti Pisani*, already one of the largest in Italy, boasting 500.000 specimens, has also been enlarged. It is at present being put in order by the new Curator. The additions to collections of living and dried specimens chiefly concern the various genera of geophytes from the Mediterranean basin, such as *Allium*, *Muscari*, *Ornithogalum*, but especially the *Orchis* and *Ophrys* which grow spontaneously on the Italian peninsula, the islands, the Balkan peninsula and in North Africa. There is an excellent collection of endemic mountain species, mainly from the Ligurian, Apuane and Apennine mountains, useful for biosystematic and taxonomical research.

CONCLUSIONS

A report by the Tuscan Region Department for Instruction and Culture, the body which finances all extra-mural teaching activites at Universities and Local Authorities, clearly emphasises the importance of the Pisa Botanical Garden's work in this city. To quote, it states "This is a cultural institute which, as well as being fully and efficiently committed to work in university education, manages to provide facilities and services for ulterior cultural activities for a much wider public."

The commitment to promoting and spreading knowledge in natural history and science is constant in the Garden; Pisa Botanical Gardens cannot forget or ignore its great beginnings and its long-living tradition.

Plan of the present Pisa University Botanical Gardens.



REFERENCES

Chiarugi A. Luoghi di fondazione dei primi orti botanici del mondo: Pisa (estate 1543), Padova (7 luglio 1545), Firenze (1 dicembre 1545). *Nuovo Giornale Bot. Ital.* 60: 783–838. 1953.

Fedeli C. Il primo orto botanico di Pisa. Ed. Simoncini, Pisa. 1917.

Garbari F. Nasce presso lo Studio pisano nel XVI secolo, la botanica moderna. In: Livorno e Pisa: due città e un territorio nella politica dei Medici. Pacini, Nistri & Lischi, Pisa., 1980.

Garbari F. Sul ruolo e l'attività dell'Orto Botanico nella didattica delle scienze. *Quaderni Provincia Pisana*, n. ser. 6: 23–29. 1983.

Garbari F. L'orto botanico un versatile strumento di studio e divulgazione attuale. *Museol. Scientif.* 2(1–2): 91–99. 1985.

Martinori G. L'Orto Botanico di Pisa. *Agricoltura* 7: 59–66. 1963.

Sbrana C. Per una ricostruzione dell'antica biblioteca del Giardino dei Semplici di Pisa. Nuovi elementi. *Physis*, an. 24, 3: 423–434., 1982.

Tongiorgi P. F. and Del Prete C. The Botanical Garden of the University of Pisa. The Herbarist 49: 67–71., 1983.

Tongiorgi Tomasi L. Inventari di Galleria e attività iconografica dell'Orto dei Semplici dello Studio pisano fra Cinque e Seicento. *Ann. Ist. Mus. St. Scienza Firenze* 4(2): 21–71., 1979.

Tongiorgi Tomasi L. Projects for Botanical and other Gardens: 16th Century Manual. *Journ. Garden History* 3(1): 1–34., 1983.

THE BOTANICAL COLLECTIONS OF THE AUSTRIAN FEDERAL GARDENS, VIENNA

ING. W. LUDWIG

Austrian Federal Gardens, Vienna

The history of the botanical collections of the Austrian Federal Gardens is closely tied with the history of the castle and gardens of SCHOENBRUNN, BELVEDERE and THE HOFBURG in Vienna. The plant collections of the Austrian Federal Gardens were basically started in the 18th century, because, of the special inclination of the Austrian royalty in the fields of natural history.

Written remarks regarding cultivation of plants go back to the year 1660 and concern citrus plants. These plants were cultivated in buckets and kept in heated houses (orangeries) during the winter season.

During the reign of Empress Maria Theresa, a Dutchman named Adrian van Steckhofen was authorized with the construction of a plant garden and in 1753 land was purchased in Schoenbrunn for the glasshouses. Consequently expeditions were made by Nikolaus Freiherr von Jacquin, Richard van der Schott and Franz Boos to Northern South America and Africa for the enlargement of the plant collections. In 1800 there were already 14 glasshouses in which more than 4000 different plants were kept. In 1894 the total number of plants reached already 6880 species belonging to 1229 genera. Based on the extensive collection according glasshouses had to be erected. The largest thereof were :

a) The Larger Orangery constructed in 1755 – a 189 m long building with a canal heating system, was assumed to have been the largest of its kind on the european continent at that time. This building is still standing today (it is a protected historical monument) and plants are kept there during the winter season.

b) In 1822 Emperor Franz Josef I inaugurated a new Palmhouse having a double glazing, 2.500 m² ground floor and 30 m height. It is also one of the largest of its kind on the europpean continent

Due to the 2 World Wars and the resulting political and economic circumstances the plant collections suffered considerable setbacks. Especially the destruction of Palmhouse (1945 till the end of WW II) through bombs, affected the collection to a large extent.

Through years of efforts the damages were removed and presently some of the singular collections are more extensive than ever and the remaining are almost as large as previous.

The following is a detailed description of the most important collections

1 SCHOENBRUNN

1.1. *Cultivation area*

The orchid collection is kept here. The very first tropical orchid under cultivation

was the *Epidendrum cochleatum* L. (around 1780). This orchid was brought back by Richard van der Schott from Westindia. According to a listing of van Boos stemming from 1816 there were at that time 10 species under cultivation. The main enlargement of the collections took place between 1893-1914. under Director Umlauft and the Gardener Hefka. During these years also many hybrids were cultivated. In Moeller's German Garden newspaper, published in 1904 they quoted that in Schoenbrunn there were at that time 90 cultivated orchid hybrids. At the end of 1913 it was estimated that the orchid collection consisted of 1500 species and 130 genera. Still in existance today is the *Cattleya hybrida* "SCHOENBRUNNENSIS"

The meritorious gardner Hefka died during WW I. After this period the collection suffered a heavy setback due to the world economic crisis and after a short rebounce was again damaged through the circumstances of WW II. But happily periods of decline are followed by new heights. Presently there are under cultivation 600 species in 10 glass-houses, that is species of orchids are mainly raised for cutting flowers.

The propagation from seeds and the Meristem System is being practiced quite successfully in Schoenbrunn's own laboratory. A collection of carnivorous plants has been built up during the last years and can be considered amongst the best

Top left — Orchid collection, Top right — Glass house
Bottom left — Orchid collection, Bottom right — *Lodoicea*

in Europe. The first VENUS FLY TRAP plant *(Dionaea muscipula)* was already presented Schoenbrunn by Joseph Jacquin, the son of Nicolaus Jacquin.

1.2. *Cacti collection*

As already mentioned the Schoenbrunn plant garden was constructed by the Dutch Hortologist, A.v. Steckhoven and in that time period the succulent collection was established. During his activity N.v. Jaquin enlarged the collection extensively, especially South African succulents.

Jacquin worked out mainly on nomenclature for stapelias, which were brought back by the young royal gardeners Franz Boos and Georg Scholl from their expedition to South Africa. He described them in his wonderful writings "STAPELARIUM IN HORTIS VINDOBONENSIS CULTARUM DESCRIPTIONES" Vienna 1806. Stemming from this expedition there is still in existence in the current collection today, the old *Fockea crispa* (Jacq.) K.Sch. syn. *Fockea capensis* Endl. This plant was shown during the World Exhibition 1889 in Paris and at the "First International Botanical Congress" 1905 in Vienna, as a Schoenbrunn rarity.

After the death of F. Boos his successors did not engage themselves very actively for the promotion of the succulents, and through the abolishment of the Monarchy and the circumstances of WW I, many valuable plants were lost. In 1970 the re-construction of the succulent collection was started again. Due to the support of the Directors it was possible for the Cultivator E. ZECHER to undertake 2 seven months trips to Southamerica for the purpose of studies and collections. Brought back from these expeditions were more than 100 new species, as well as many lost plants were found. During the last years several expeditions were made to Mexico and the South of the U.S.A.

In 1976 the Schoenbrunn succulent collection was declared as a model collection during the I.O.S. Congress in Barcelona, and also authorized with the conservation and propagation of endangered plants.

1.3. *Palm collection*

The year 1978 marked the start of enlargement of the palm collection, which presently covers 56 general, amongst them rarities such as LODOICEA maldivica. Most of these plants are still in their youth period and are planned to be exhibited in a showhouse (Palmhouse) to the general public. Aside from this the greenhouses in Schoenbrunn house a number of small plant collections, such as Begoniaceae, Gesneriaceae, Ferns, as well as a large *Azalea* collection.

1.4. *Sundial house*

This 1130 m² large temperated greenhouse was constructed in 1904 and houses a permanent plant collection, which is open to the general public. It is subdivided in 3 climatic zones (subtropical, vegetation of the dry areas and tropics). This showhouse is an alternative for the presently being renovated Palmhouse.

1.5. *Botanical Garden*

Shrubs and trees specifically adjusted to our cold climatic zone are planted in this approx. 11 ha Arboretum.

2. BELVEDERE

2.1. *Alpine Garden Belvedere*

The Botanist H. Schott made cultivation tests and also descriptions of alpine plants in the 19th century, and laid one of the cornerstones for today's collection. Schoenbrunn housed a alpine plant collection since the year 1802. After Schott's death in 1865 the plants were removed to the

castle Belvedere as an addition to "Flora Austriaca" which had been started in 1793 by von Host due to a special wish of the reigning emperor.

Rock groups and also a alpine house were added eventually. In this oldest alpine garden in Europe having an area of 2.500 m², a total of 4.000 plants are cultivated. Rare plants are old examples of *Hutchinsia persica, Rhamnus pumila, Genista holopetala*. Also still in existance is the Pleione limprichtii stemming from a collection of the province Yunnan, China in 1922. A collection of original Japanese Bonsai is also available.

2.2 *Cultivation area, Belvedere*

In glasshouse areas amounting to 2.300 m² which were constructed beginning with the year 1923, the following plant families are cultivated.

BROMELIACEAE	13 genera and 350 kinds and species
ARACEAE	approx. 70 species
MORACEAE	approx. 50 species

Additionally a number of tropical ornamental — and useful plants Wilhelm Schott started the Araceen collection during the years 1817-21, since he participated in an expedition to Brazil during those years.

A special collection is the group ERICACAE with 79 species of S-African, as well as 2 genera with 111 species, of the native Ericaceae. According to our information this collection presently is one of the largest in Europe.

Singularly unique is the collection of plants native in the Australian and New Zealand areas. They are being cultivated for centuries here, and they were originally contributed by Baron Huegel.

In summation it can be said the plant collection of the Austrian Federal Gardens are currently not subject to scientific studies, but are either protected plant collections, or a continuation of the collections stemming from the tradition of the former royal Gardens. The collections are the property of The Republic of Austria.

Enlargements of collections must be considered in reference to other assignments of the Federal Gardens and are therefore only possible in a limited frame. Parts of the above mentioned collections are exhibited in shows to the general public, but generally can only be seen with special permission.

Based on the following listing, the reader may get a general view about the size and structure of the Federal Gardens.

Owner **Republic of Austria** —
Ministry of Agriculture
A-1010 Wien, Stubenring 1
Administration of the Federal Gardens
A-1130 Wien, Schoenbrunn

Administation Schoenbrunn and Hetzendorf

A-1130 Wien Schoenbrunn

Total Area	154 ha	
Number of glasshouses		56 (thereof 1 orangery, 2 showhouses)
Total size	18.880 m²	

Administration Belvedere

A-1030 Wien, Prinz Eugenstr. 27

Total Area	13 ha	
Number of glasshouses		14 + 1 alpine house
Total size	2.415 m²	

Administration Burggarten

A-1010 Wien, Josefsplatz 1

Total Area 16.4 ha
Number of glasshouses : 1 (showhouse)
Total size 1.450 m²

Administration:Augarten

A-1020 Wien, Obere Augartenstr 2

Total Area : 45 ha
Number of glasshouses 2
Total size 300 m²

General view about location and climate

VIENNA . geogr latitude 48° north
geogr. longitude 13° east of Greenwich

Altitude above sea level : 171 m
Yearly down fall 676 mm (1901-1960)
Clima Temperate cont. clima still maritime influenced
Average yearly temperatures + 9.5° C (1901-1960)
Average snow covered days : 45 days (1901-1960)
Average sunshine (hours) per year : 1837

Director of the Institution Hofrat Dipl. Ing E. Kaven

DURHAM UNIVERSITY BOTANIC GARDEN

D. BOULTER AND S. ANSDELL
Department of Botany, University of Durham, England

In 1967 a site was made available to establish a new Botanic Garden at Durham University; it is, therefore, one of the youngest Botanic Gardens in the British Isles.

The concept was to provide teaching materials to the Department of Botany although since systematics form a smaller part of University courses in Botany, only small collections are maintained for this purpose. The Department of Botany carries out innovative research in well-equipped laboratories which involves collaboration with many other agricultural and horticultural institutes and industrial sponsors. These require considerable plant materials and it was envisaged that the gardens should play a major role in satisfying these requirements. Thus, provision was made for an automated research glasshouse range extending to 50,000 sq. ft. with the ability to provide a number of different climatic conditions, with supplementary lighting, mist propagation benches and other techniques. There are also experimental gardens and a four-acre nursery. In relationship to agriculture, horticulture and the national flora it was felt that the gardens should play an important role in collaboration with the Department of Botany in holding certain seeds and gene banks wherever these facilities were not catered for in centralised centres. To help to conserve the regional flora was another priority. This was to be accomplished by establishing a nursery collection of plants in areas threatened by disturbance, by maintaining a herbarium and by removing some pressure from original nature reserves by holding displays.

The guiding principles underlying the development of the Garden were that it should be established on a sound ecological basis. Thus, plantings are not in generic groups but in mixed populations providing ecological and plant geographical information, as well as to give aesthetic pleasure. Since the Garden is set in an ideal location with adjacent woodland, it was decided that the development of the Garden would complement the existing landscape policy of the University Estate and include extensive tree plantings. A strong element of conservation was to be included in the Garden policy and it was envisaged that the Garden should include activities which would maximise the Garden's use, as well as integrate the University with the local community.

Collections of plants are grown to display a number of distinct habitats, which means that the visitor to the Garden can observe some of the exotic floras of the world. As well as two non-temperate floral types represented under glass, these being the tropical rain forest ecosystem and the arid zones, the following temperate flora are represented in the Garden.

Lindernia brucei

1. Central European Woodlands
2. Yugoslavian 'Omorika' Spruce association
3. North American Woodlands, representing nine forest types, as follows
   - 3.1. Northern Boreal
   - 3.2. Northern Hardwoods
   - 3.3. Mixed Mesophytic
   - 3.4. Pinus contorta
   - 3.5. Tsuga heterophylla
   - 3.6. Pseudotsuga menziesii
   - 3.7. Pinus ponderosa
   - 3.8. Sequoia sempervirens
   - 3.9. Sequoiadendron giganteum

Also, some interesting plants from Western, Central, North Eastern and Southern North America are represented

4. Temperate Himalayan Vegetation
5. Chinese and Japanese
6. County Durham Wetland Plants and other European plants notably Salix species
7. Swedish mixed Coniferous Woodland
8. Temperate Chilean

Other areas of interest include a heather garden, herbaceous borders, rose garden and a garden showing ornamental forms of North American conifers.

The Botanic Garden also holds a small collection of plants that are either rare or threatened in their natural habitat, one of these being *Lindernia brucei* (Fig. 1). A member of the Scrophulariaceae, the genus itself is common enough in Asia, but *L. brucei* exists only on the upper reaches of the Le Soufriere volcano on St. Vincent. It was thought to have become extinct by the last volcanic eruption in 1979. However, a recent Durham University expedition to the island rediscovered it and it now grows quite successfully in the tropical glasshouse.

THE BOTANICAL GARDENS IN COPENHAGEN

JETTE DAHL MOLLER

Jardin Botanique de lá Universite, Copenhagen

The Botanical Gardens in Copenhagen belong to the University of Copenhagen and as such are responsible to the Danish Ministry of Education. They are maintained principally to provide opportunities for scientific studies and education. However, due to their location in the centre of the capital, the Gardens daily throughout the year serve as a popular recreational area for both Copenhageners and tourists, with approximately 700.000 visitors annually. Copenhagen has a northerly temperate climate, is situated 55°41'N and 12°34'E at an altitude of 5--10 m above sea level and has an annual precipitation of approx. 600 mm.

The staff of the Gardens comprise 6 curators (including a plant taxonomist), 40 gardeners, 13 technicians and 6 security officials. They are responsible for the supervision, cultivation and preservation of some 25.000 species both under glass and in the open. The first Botanical Garden in Copenhagen was established in 1600. The present one is the fourth in line and was laid out between 1872 and 1874 on 9.75 ha of a former fortification system which is still evident in the contours of the Garden's varied and distinctive landscape. Part of the original moat is preserved as a long, narrow lake along whose banks swamp plants have been cultivated. Areas of the embankment slopes have been supplemented with calciferous bed rock in order to maintain an interesting rock garden with chalk-loving and alpine plants. The remaining slopes are covered by a valuable collection of Conifers and Rhododendrons. Other open areas are devoted to comprehensive collections of annuals, perennials, historical species of Roses, nursery plants and a display of the wild flora of Denmark.

In 1985 practical work was started with plant tissue culture in connection with the projected meristem laboratory. This is to be concerned especially with the culture of threatened plants, propagation of Orchids and general renewal of the Garden's collections. The extensive seed bank provides a basis for further studies of germination and optimal conditions for seedling growth and establishment.

Due to the periodically harsh climate it is necessary to maintain tropical, subtropical and Mediterranean plants under 4000 m² glass. The central greenhouse, successfully restored to its original architectural beauty in 1982, is the palmhouse where tropical crop plants and Palms are able to thrive.

The glass house complex also provides the necessary conditions for the valuable collections of Orchids, especially from Thailand, Cactus and other succulents. Cold glass houses are designed to be suitable for the cultivation of arctic plants, especially those from Greenland, and alpine

species of which there is a rich selection from the greecian flora.

An arboretum of 5,4 ha, 75 km SW of Copenhagen has been laid down to serve as a supplement to the Botanical Garden's arboretum. In addition the Gardens have access to experimental fields of 6 ha where, among other things, a large selection of wild potato species are cultivated

Seeds are harvested each year from nature in Denmark and Greenland and from within the Botanical Gardens. Catalogues of those are sent to c. 300 botanists both in Denmark and abroad. The Botanical Museum and other botanical departments are in close proximity to the Botanical Gardens and this allows for a valuable collaboration between the employers and is advantageous for students and for visiting research workers.

MUNICH BOTANICAL GARDEN

FRANZ SCHOTZ AND JOSEF BOGNER

Botanischen Gartens, Munchen, Federal Republic of Germany

HISTORY

The Munich Botanical Garden was opened in 1812 as an institution of the Bavarian Academy of Science, which had been renewed in 1807. It was laid out on a 5 hectare site then outside the town. Besides the area for hardy plants there was already a greenhouse with a 120 m long glass front, very large for that time. By 1851 more than 10,000 species were in cultivation in this relatively small area, 5,040 in the greenhouses alone. This number of species is nearly the same found in botanical gardens today. However the garden was soon surrounded by the growing city, and the main railway station was constructed nearby. Smoke and soot of the domestic fires and the train engines and also toxic gases of the increasing number of factories lead to such great damages to the plants (especially the evergreens), that the resiting of the garden became imperative, and it was finally effected about 100 years after its founding. Now the old garden is recalled only by a small municipal park, the "Old Botanical Garden" lying in the centre of Munich today.

The new garden was established on a 20 hectare site outside Munich near the Nymphenburg castle. This area was in a good natural state and seemed to be preserved from encroachments; it was not too far away from the town and easy to reach. Moreover, the garden could get there its independent water supply. The resiting operations were carried out under the supervision of Professor Karl von Goebel, director of the garden at this time; the plans and their execution were the work of Peter Holfelder, appointed as horticultural engineer. Not only were smaller plants removed from the old to the new garden, but also approximately 120 botanical valuable old trees, which were transported with frozen balls. The new garden was opened at the 10th May 1914. Unfortunately the expanding city has reached it again today, but nevertheless another resiting further from the centre of Munich, for various reasons, cannot be contemplated. Everything must and will be done to maintain it on its present location.

The new garden was from its beginning not only to be a pure scientific institution of the Academy as the old garden had been, or a teaching and research institute on an university level, a function which it got in 1826 as Munich became the seat of a university. It was also to be a general place for information, knowledge and relaxation for the broadest circle of people. Therefore not only scientific views were considered for the planning of this garden but esthetic ones too. The usual systematic arrangement of plants was changed in favour of plant-geographical and ecological arrangements, landscape and esthetic

views. Hence a multipurpose garden arose; something quite new at that time, and still considered as a model to-day.

THE OUTDOOR DEPARTMENT

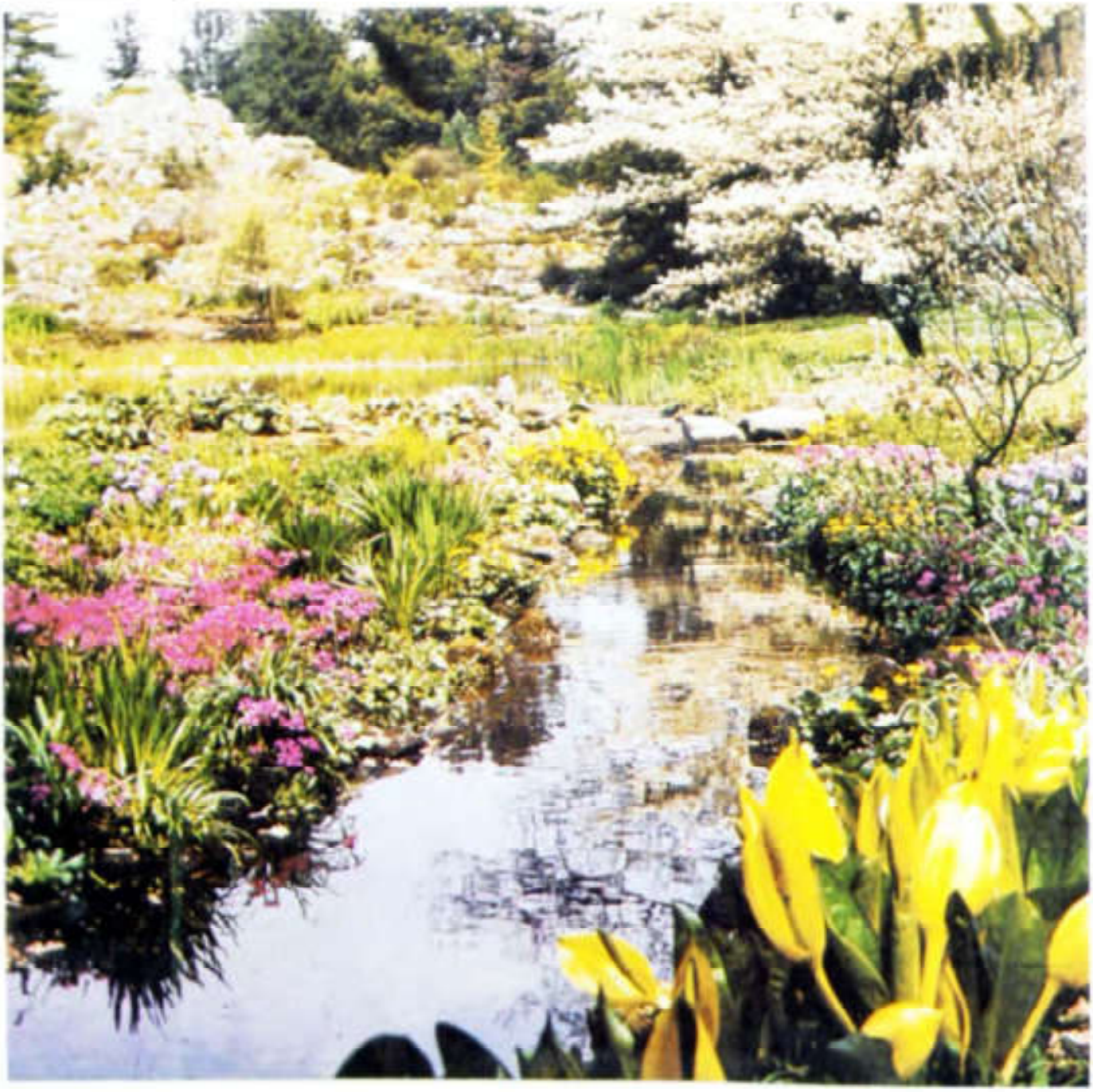
The path from the main entrance leads first to the most showy part, a somewhat deepened Ornamental Garden, called "Schmuckhof". The bloom of the many various plants changes here according to the seasons. On its north side is a large building, erected in the "Jugendstil" (a German style of architecture at the beginning of the 20th century), that houses the Botanical Institutes of the University of Munich and the Bavarian Botanical State Collection (Herbarium). South of the Ornamental Garden are the Ecological and Genetic Sections, both framed by a Pergola overgrown by many different climbing plants. These sections offer the visitors many information, and the texts of the labels explain in detail the scientific facts presented by the plants.

Autumnal Aspect of the Ornamental Garden

In the large Arboretum the trees and shrubs are arranged by families in the old style but nevertheless with a harmonious silhouette.

Special pains are taken with the culture of alpine plants because of the vicinity of Munich Botanical Garden to the Alps. The approximately 3,000 m^2 large Rock Garden contains, in geographical arrangement, not only plants from the high mountains of Europe but also from other mountains of the world, altogether ca. 1,500 species. Such plants, requiring a more intensive care, are grown in an Alpine House completely reconstructed in 1971. There is also an Alpine Garden of 1 hectare size belonging to Munich Botanical Garden at 1,850 m altitude on the Schachen near Garmisch-Partenkirchen. Many alpine plants grow much better in the relatively natural habitat there. This garden was established in 1901 and contains today approximately 1,000 species.

Colourful Spring Flowers



The Large Pond south of the Rock Garden contains aquatic plants and, along its borders, plants of wet areas. Some different bog areas, heath, steppe, dune, and a bed for the arctic tundra are united as Plant Geographical Groups.

The so-called Fern Valley gives favourable life conditions for many ferns and other shade-requiring plants of the temperate zones. They valley is shaded by large trees, and an artificial brook runs through, increasing the moisture. About 200 species and cultivars of Rhododendrons are grown in the following somewhat lighter Rhododendron Grove. They need humus, acidic and calcium-poor soil. Therefore during the construction of the garden the local

View of the Rock Garden

The Rhododendron Grove

gravely soil was replaced by a calcium-poor substrate. This work has to be repeated after certain intervals.

The Historical Rose Garden shows examples of the most important rose groups that have played roles during the long history of breeding garden roses.

The Section for Protected Plants shows many endangered or even nearly extinct species of Germany that are recommended for visitors protection.

The Systematic Section is placed on the southeast corner of the garden apart from the main stream of visitors. Nevertheless it is a major part of the garden and contains ca. 1,600 species, which can be grown outdoors in our climate. The plants are arranged according to their relationship and phylogeny.

THE GREENHOUSES

The greenhouses cover an area of 8,500 m^2, 5,000 m^2 of which are used as show-houses for the visitors, the others are cultural-houses not open to the public. An axis of three big greenhouses (called Halls A, B, C), together 85 m long and 14 m wide, arranged in east-west direction, is very dominant. The middle Hall (B), 37 m long and 10 m high, has a 23 m high

Victoria House in Summer

House for African Succulent Plants

Ceropegia sandersonii (Asclepiadaceae) from Natal

The Cacti House

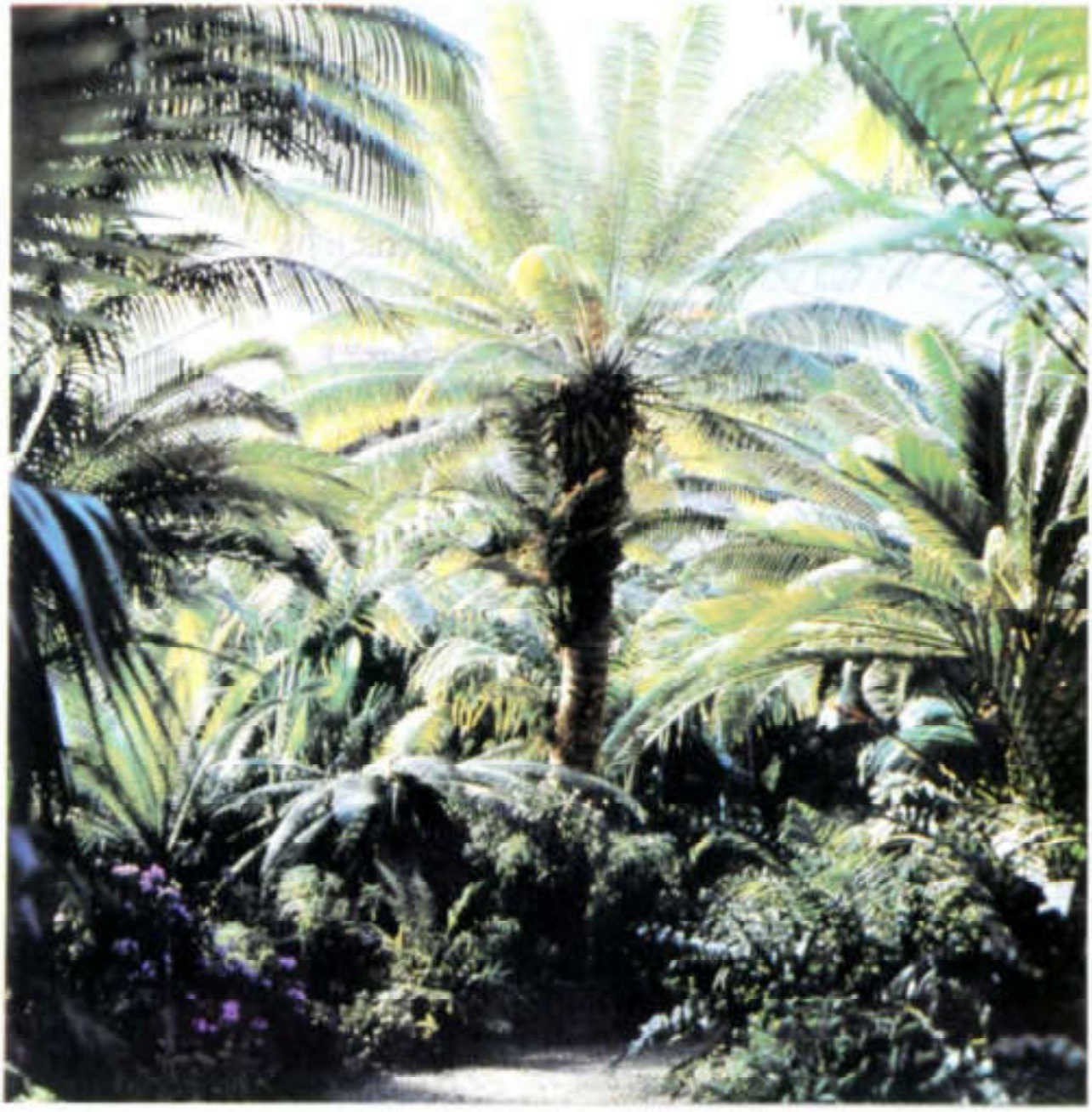
central dome, the other two are each 24 m long 9 m high. From this axis six greenhouses branch southwards and five northwards, each of them 27 m long. Their width and height are different, depending on the type of the cultivated plants. According to this arrangement of the show-houses the visitors can use one path through all of them without going outside, and the houses are also protected from cold air coming through several openings during the winter.

By the ravages of time, in particular also by aerial attacks during the second world war, the metal and wood constructions of many of the greenhouses were so strongly corroded and damaged, that repair finally was no longer economic or even impossible. The technical equipment was no longer up to date too, and did not meet modern standards. Moreover, the old greenhouses did not allow a modern display of the plant material. Therefore, after some preceeding enlargements and improve

ments, a large part of the show-houses was completely new constructed from 1974 to 1984. The remaining old houses were fully repaired. Only two Temperate Houses and the Platycerium House are still in the original state, but their upgrading is expected for 1987/88.

The first of the big greenhouses of the main axis (Hall A) contains large xerophytic plants, especially tree-like monocots (Dracaena, Aloe, Yucca) and leaf succulents (Agave, Aloe). The new Orchid House, covering an area of 350 m^2, is branching southwards from here. Approximately 2,000 species and cultivars of tropical orchids are grown in the garden. Only a few of these, which are morphologically interesting even without flowers, are permanently displayed in this show-house.

The House of Cycadaceae



The remaining orchids are only exhibited when they are in bloom, giving the impression of constant flowering. The major orchid collection is kept in the cultural-houses, where better care can be taken of them. Besides orchids this show-house contains also many smaller plants of tropical forests. In a separate section at the southern end of the house are mainly Nepenthes, of which one third of the known wild species is present as well as several hybrids.

The central greenhouse (Hall B) with the dome is used as a Large Tropical House with more than 50 palms among many other species. Three greenhouses are directed southwards from here. The first contains tropical economic plants. The second is the Victoria-House, which is probably the biggest in Europe with a water basin of 18 m length and 9 m width. It serves during the winter as a Temperate House with trees and shrubs from the Mediterranean area, Australia, South Africa

View over the Ornamental Garden in Summer

and southern South America (Chile, Argentine). They are set outside during the summer. The third house contains plants of tropical swamps and aquatic plants. This collection, including the aquarium plants, is very rich in species. There are 15 aquariums, the largest is nearly 2 m^3. Mangrove plants grow in one of the big middle basins. A separate cooler section at the southern end of this house contains insectivorous plants, except species of Nepenthes, which require higher humidity and warmth (cf. Orchid House).

The collection of cacti and other succulents at Munich Botanical Garden is important. Very large stem succulents of euphorbias, pachypodiums and cacti are impressive for the visitors in the last big greenhouse of the main axis (Hall C). In one of the two green houses branching southwards from here succulents of the New World only are grown, i.e. mainly cacti, especially in bigger specimens. The second house contains, besides many smaller cacti, a great number of African succulents belonging to more than 25 families and to many genera. Such a great number of different plants, approximately 2,500 taxa, is to be found nowhere else in the garden in the same space; e.g. three quarters of the hundred Aloe species present in the garden are concentrated there. The Crassulaceae, especially species

The Genetic and Ecological Section

View from the Rock Garden

of the genus Crassula itself, are richly represented. This genus is monographically studied by our Landeskonservator, Dr. H.-Chr. Friedrich. A special section has separate temperature and humidity regulation for the culture of *Welwitschia mirabilis*. Altogether there are more than 800 m^2 for succulents only.

A narrow shady greenhouse on the north side of the complex of Succulent Houses is used for a collection of mosses and ferns, especially for filmy ferns (Hymenophyllaceae). It is not open to the public.

From the Large Tropical House (Hall B) three smaller greenhouses branch to the north. The first, which replaced the old original in 1982/83, contains mainly aroids, gingers and bromeliads. Some of them can be seen also in other greenhouses, but especially the bromeliads are concentrated here. Parts of the large aroid collection also are to be found in other places.

Group of Birches in the Arboretum

depending on cultural requirements. Besides the well known species this collection contains also a lot of rare and seldom cultivated types of this mainly tropical family. Many of the aroids were collected by one of the members of our staff, J. Bogner, who specializes in this family. The second house branching northwards from

The Fern Valley in Summer

Hall B contains the cycad collection with approximately 30 species; some are about hundred years old and therefore very valuable. Tree ferns grow in the third of these greenhouses. It is only 6, 5 m high, and therefore unfortunately the older specimens must be cut before they reach their full height. Many other ferns from the subtropics and from higher altitudes of the tropics are combined with the tree ferns. Also the Begonia collection is presented in this house, and there are gesneriads in a separate section on its end.

Two smaller show-houses branch to the north from the first big greenhouse (Hall A). During the summer they contain usually house plants; during the winter they are used as temperate houses. Both houses are connected on their ends by a stove house with an impressive collection of all fifteen known species of staghorn ferns (platyceriums). This complex of greenhouses is scheduled for rebuilding in the next years.

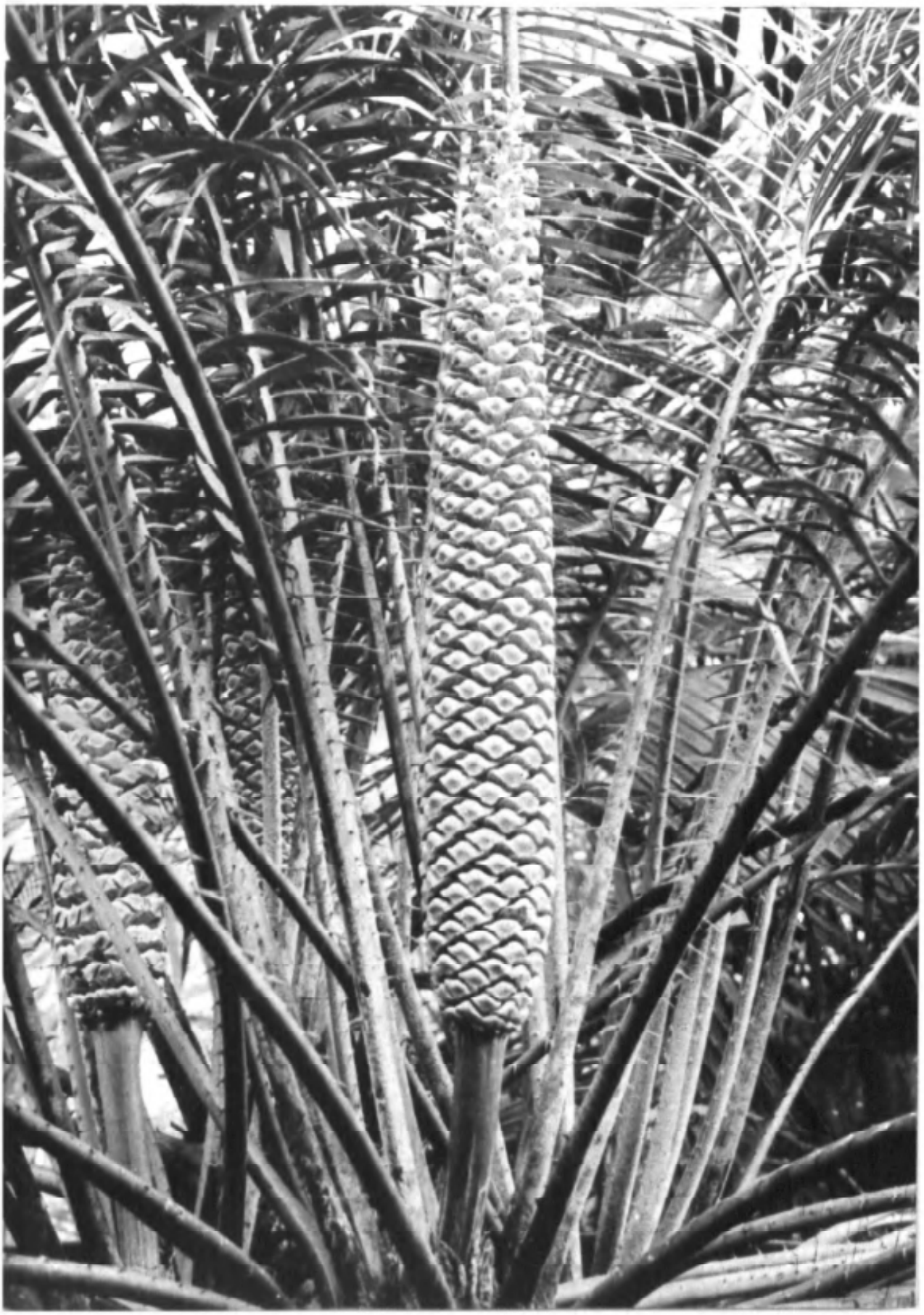
RESEARCH, TEACHING AND INFORMATION OF THE PUBLIC

The scientific work in the garden is mainly taxonomic; research on Crassulaceae and aroids was already mentioned. The taxonomy of certain Primulaceae is

House for Arboraceous Liliaceae (Hall A)

Interior of the Large Tropical House (Hall B)

A male Flower-Cone of Encephalartos villosus



studied by the Oberkonservator, Dr. A. Kress. Prof. Dr. Franz Schotz, the present director of the garden, is doing research on certain groups of the genus Oenothera involving extracaryotic genetics of plastids and the consequences of it on the ultrastructure of chloroplasts. Research in and with the garden is operated in the fields of systematics, morphology, physiology and genetics in the Botanical Institutes of the University of Munich and the Bavarian Botanical State Collection (Herbarium), both situated in the garden area.

The Institutes of the University use the garden also for their teaching. Lectures on systematic botany and various practical courses are extensively supplied with plant material from the garden. Further the garden serves as a "living textbook" for all students of biological sciences, including also the Botanical and Agricultural Department of the Technical University of Munich and the College for Horticulture in Weihenstephan as well as the School of Horticulturists in Munich. The number of students visiting the garden each year is approximately 45,000. The garden itself does not belong to the University, since — as mentioned at the beginning — it was established in 1812 as an institution of the Bavarian Academy of Science before the University (1826) came to Munich. This official independence is still maintained.

House of Tree-Ferns

nevertheless the garden no longer belongs to the Academy, but to the general direction of the Natural Science State Collections of Bavaria. But there is still a connection with the University, given by the fact that the garden directors are traditionally professors at the University of Munich.

Classes of primary and secondary schools accompanied by their teachers — approximately 20,000 pupils every year — use the garden for practical lessons. The Alpine Garden at the Schachen has ca. 7,000 interested visitors each year in spite of its long distance from the next village. Altogether about 300,000 visitors use the Munich Botanical Garden every year for a studies, information, relaxation and recreation.

Staghorn Ferns

THE BOTANIC GARDEN OF THE JAGELLONIAN UNIVERSITY IN KRAKOW (CRACOW), POLAND

KAZIMIERZ SZCZEPANEK

Botanic Garden, The Jagellonian University, Kraków, Poland

This paper is presenting the oldest garden in Poland, two hundred years old Botanic Garden in Cracow. The Garden has been founded at the end of the eighteenth century. It is situated in a moderate zone on the area of 9.8 ha. About 5 000 taxa of vascular plants have been grouped into several sections: plant taxonomy and plant genetics divisions, flower ecology and morphology division, medicinal and agricultural crop plants division, water and swamp plant division, rock and mountain plants division and ornamental flowers division. Geographical and ecological plant groups are also presented. In glasshouses there tropical and subtropical plants are grown. Some museum pieces like wood samples, fruits and seeds have been also collected in the Garden. Recent scientific activity in the Garden is connected with the Botanical Institute of the Jagellonian University. The collections of the Garden are widely used by research workers and by the students. A role of the Garden as a recreation place for inhabitants of Cracow is pointed.

POSITION OF THE GARDEN AND ITS ECOLOGICAL CHARACTERISTICS

The Botanic Garden is situated in the centre of the town, 208 m a.s.l., on the terrace of the river Vistula. Its position is determined by 19°58' East longitude and 50°04' North latitude.

At present the area of the garden is 9.8 ha. The bed of the Garden is composed of Miocene loamy silts, 12 to 15 m beneath of the surface as well as of Pleistocene Gravel-sand-peaty drifts, 12 to 15 m thick. The natural fluctuation of the ground-water-level was ca 0.5 m. But after 1966 the initial basis was lowered ca 0.8 m and the amplitude has been increased up to 1 m.

The climate is characterized by the following factors, (based on the 100 year observations) :

— mean year temperature oscillates between 5.5 and 9.9°C (most frequently 8–9°C),

— mean January temperature, −4.0°C to −0.7°C

— mean February temperature 0.0°C to +1.9°C

mean July temperature + 18.0°C to +19.9°C

— the highest recorded temperature +37.4°C (August)

— the lowest recorded temperature −33.1°C (February)

— the mean year rain (snowfall) is 665 mm (420 to 900), the winter time lasts 70 days as an average, the vegetation period lasts 222 days, but the period of intense developmental processes is only 165 days. The number of days with the snow cover may oscillate from 35 to 114

THE HISTORY OF THE GARDEN

The Cracow Botanic Garden, the oldest of all Gardens still existing in Poland, was founded in 1783 and the first head of the Garden was professor Jan Jaśkiewicz. Its initial area was 2.5 ha. In 1786-87 two glasshouses were built and at the end of the eighteenth century about 3 000 plant specimens were grown in the Garden. They originated from the vicinity of the Garden as well as from other European Botanic Gardens. The first catalogue of plants for exchange was issued in 1806. This publication have contributed to the establishment of the contacts with many other Gardens and still exists as an annual "Index Seminum"

The area of the Garden was increased for the first time in 1819-1825 to 3.6 ha (the last extension occurred in 1958). The greatest increase of the plant collection took place in the second half of the XIX century, under the direction of professor Ignacy Rafal Czerwiakowski. The plant catalogue of 1864 comprises nearly 10,000 plant species and varieties grown in the Garden.

In 1878, when professor Jozef Rostafinski was the head of the Garden, the botanical laboratory was set up. He has introduced in this laboratory for the first time in Poland, research lines, like plant taxonomy and anatomy, physiology, phytopathology. However, when in 1913 the

The oldest tree in Garden's Collection

Botanical Institute of the Jagellonian University was founded (by professor Marian Raciborski) it soon became the main centre of botanical research.

In 1917-1960 under the guidance of professor Wladyslaw Szafer the modern development of the Garden has begun. He has increased its area, built new glasshouses, set up many plant collections etc. All these investments gave the Garden its present shape.

In 1976 the Botanic Garden was recognized as a monument of the history of botany in Cracow and national centre for horticulture.

In 1983 in 200 anniversary of the Garden a Museum of history of the Garden and of botany in Cracow was established. In the same year an archives in which documents of history of Polish botany was set up.

PLANT COLLECTIONS

About 5.000 taxa of vascular plants are cultivated in the Garden. They have been divided into several sections and geographical groups. The sections present some problems of particular fields of botany.

The plant taxonomy division (according to Wettstein's system). It dates back from the second decade of our century and it is maintained in the same shape till the present. The system of flowering plants is represented by about 700, mostly native, plant species.

The division of plant genetics (variability and evolution): about 100 species and varieties present there some problems of classical genetics *e.g.* Mendelian principles, gene and genome mutations (polyploidy), artificial intergeneric hybrids, wild ancestor forms of some crop or ornamental plants, examples of atavism etc.

The division of flower ecology, morphology and flower biology: About 50 plant species present various mechanisms of pollinations, mechanisms preclusive of self-pollination, flower adaptations to particular pollinators and some examples of seed dispersal mechanisms. Some morphological transformations of plant organs are also presented.

The division of medicinal and agricultural crop plants: about 400 plant species have been grouped according to their active substances. Examples of crop and industrial plants are presented separately.

Water and swamp plant division: in outdoor basins and artificial ponds there

A view of the garden

are native (mostly) and introduced water plant species as well as seminatural communities of that type (ca 70 species).

Rock and mountain plant division: This is a collection of about 700 taxa — mountain species. There are plants typical largely for the Carpathian range and some taxa frequently used for rock-garden compositions.

Ornamental flower division has been conceived as the decorative arrangements, spread all over the Garden area. For this purpose some perennial plants as well as seasonally changed annuals and biennials have been used.

In all divisions the spatial distribution of plants is conformed to their decorative appearance.

In glasshouses there are collections of about 2.000 plant species and varieties originating mostly from tropical and subtropical regions of all continents. The species are grouped into three blocs of glasshouses (of the global area of 2.500 m^2). The different plant groups are cultivated in separate blocks.

In the hottest and the dampest part of a glasshouse there are grown tropical water plants, lians, representatives of the family Araceae and a few trees and shrubs typical of tropical regions. There are also collections of tropical and subtropical ferns.

In houses with lower temperature and air moisture there are grown succulent plants, illustrating most of all the phenomena of convergence (about 1.000 taxa, from which 600 belong to Cactaceae). Some

A view of plant-system beds

plants from warm regions are grown through the winter in similar conditions but during the vegetative season the geographic groups are formed from them in open air. Such groups are formed from representatives of South American, South African, Australian, New Zealand, China and Japan flora, as well as of Mediterranean region vegetation. In separate Palm-houses there are collections of about 20 species of Palm-trees, tropical and subtropical economic plants, representatives of Cycads (3 families, 10 genera) and the genus Ficus (16 species). The tropical Orchids (about 300 species and varieties) and representatives of Bromeliaceae (about 130 species and varieties) are grown in separate houses.

Some plant specimens in these glass-houses have been grown for about 100-150 years. As the examples may serve some Cycads, dwarf Cedrus and Chamecyparis, Phoenix canariensis, Cyrtopodium andersonii and a few others

Arboretum has taken the most part of the Garden area and it comprises about 1.000 taxa of trees and shrubs (ca 6.000 specimens). These trees and shrubs are grouped according to their geographical origin. Most of them have been artificially planted. The only natural specimen it is a 500 years old oak-trees (*Quercus robur*, Pot. 1). In the oldest part of the Garden many of trees are 150-180 year old. From the geographical point of view most

Ornamental rock-garden in autumn

Flower bed in the arboretum

numerous are trees and shrubs from Europe, Eastern part of North America and North-eastern Asia. Other geographical regions are represented only by not numerous taxa grown in glasshouses, because of their climatic requirements. The mutants and varieties are not separated but introduced into scenery compositions.

Owing to numerous trees and shrubs planted in the Garden there is rather limited area of open space for growing of herbaceous plants, requiring, as a rule, more light than the other. Therefore besides mentioned above divisons of taxonomy, genetics, flower ecology and morphology, the herbaceous plants are grown on small areas in some groups of particular ecological requirements and on ornamental flower-beds.

In the Garden for many years there have been collected some museum pieces, such as wood samples (native and foreign, about 1.000 specimens), fruits and seeds, mostly exotic (tropical and subtropical, ca 1.500 specimens), paleobotanical collections (ca 700 specimens) and the herbarium specimens of trees and shrubs grown in the Garden. A separate collection is formed from the specimens brought from Java by professor Marian Raciborski (347 dendrologic specimens, fruits and seeds — 450 specimens). These collections are used in special courses for students as well as in museum exhibition for illustrating the history of botany in Cracow.

SCIENTIFIC ACTIVITY AND UTILIZATION OF THE COLLECTIONS

The main role of the Botanic Garden is an auxiliary function for the Institute of Botany of the Jagellonian University. Scientific activity of some research workers in the Garden include various lines of botany and geobotany in wide sense, plant cytotaxonomy and the history of plants and of botany. In recent years they contribute to the plant ecology, particularly in relation to very rare or dying out species. For many years the phenological observations have been made, as well as some informations concerning the plant acclimatization and the methods of cultivation of introduced plants of foreign origin have been collected.

The collections of the Garden are used by botanists of various disciplines, e.g. plant taxonomy, physiology, cytotaxonomy, genetics, ecology, horticulture, forestry, pharmacy, mycology and algology. The results of their research, carried out on materials from the Garden are published in various, mostly Polish journals. The purely Garden journal is "Index Seminum" edited annuallysince 1806. The collections of the Garden serve also as the instructive materials to schools of all ranks as well as to specialists and practioners of horticulture and forestry. However, students of biology in University and of technical High schools (horticultural, agricultural) use them to the most extend.

The Garden offers, in the great part without charge, plant materials to schools, institutions and even to botany lovers.

The Garden is also a favourite recreation place for inhabitants of Cracow and not less than 150 thousand people visit it every year.

An exchange of plant material (mostly fruits and seeds) is carried on with Polish Botanic Gardens, private people and with about 250 foreign institutions.

At about 15 km of the main Garden there was formed in 1976 the branch of the Garden, founded on the area of 7 ha of an antique park. Here a nursery garden of young trees and shrubs has been located. Also an experimental field for the

cytogenetical and embryological studies has been set up there on a separate area.

The main Botanic Garden has been situated at first on an outskirts of Cracow, however, as a result of an expansion of the town it is lying at present just in the centre of the urban agglomeration. As a consequence, the Garden has very limited chances for an extension of its area. Constantly getting worse conditions and increasing air pollution decrease possibilities of growing more sensitive plants. Therefore in the perspective plans of extension of the city also the foundation of a new Botanic Garden has been provided. It will be localized in a new site on much bigger area. The old Garden, however, will be preserved to continue with all its present functions because of its historical value.

A STATE-OF-THE-ART REPORT OF THE BOTANIC GARDEN BERLIN-DAHLEM

HARTMUT ERN

Botanic Garden, Berlin-Dahlem, Federal Republic of Germany

The origins of the Botanic Garden Berlin-Dahlem date back to the year 1679 when the 'Great Elector' Friedrich Wilhelm created in Schoeneberg near Berlin an herb and kitchen garden for his court. From the very beginning this garden, with an area of about 7 hectares was assigned to introduce new methods of gardening and agriculture to the then rather poor and backward country of Prussia. The successors of Friedrich Wilhelm, the Kings of Prussia, added glasshouses and other installations to the garden which gradually became a Botanic Garden in the modern sense. In 1718 the Prussian Academy of Sciences became responsible for the garden and its plant collections began to serve the scientific purposes of the learned institutions of Berlin. Internationally reputed Botanists worked with the new garden, Gleditsch, Willdenow, Link, Chamisso, Kunth, Urban and many more. In 1846 Kunth listed 16,000 cultivated plant species in his General Catalogue.

In 1856 the garden was enlarged by another 4, 5 hectares of ground and in 1880 a Botanical Museum was built which contained also a display section. Gradually, however, the area of the garden became too small for the growing demands and the buildings of the rapidly expanding city of Berlin began to encroach closer and closer. Under the directorship of A. Engler the foundation of a completely new Botanic Garden near the small village of Dahlem was planned. 42 hectares of ground were purchased from a big rural estate and in 1910 the new institution, the "Koenigliche Botanischer Garten und Koeniglich Botenisches Museum" ("Royal Botanic Garden and Royal Botanical Museum") was officially opened by the participants of the International Botanical Congress in Brussels who came for this occasion to Berlin.

Between 1871 and 1914 the "German Empire" had become one of the last European countries to obtain colonies in the Tropics. Consequently, the main botanical institution of the country, the Botanical Garden and Botanical Museum of Berlin-Dahlem, was charged with the botanical exploration of those new German colonies, mainly being situated in Africa (Cameroon, Tanzania, Togo, SW-Africa), but also in the Indo Pacific region (eastern half of New Guinea, Samoa etc.). A late consequence of these historical events has been the recent publication of the "Flore analytique du Togo" (Englera 4, 1984) by our institute.

There was a steady flow of herbarium collections arriving at the Dahlem Herbarium in those years and hundreds of type-specimens accumulated there. Engler and his botanists worked very hard on this enormous material and they described a lot of new taxa. The institution also edited such big botanical classics like "Das

Pflanzenreich" "Die natuerlichen Pflanzenfamilien" and "Die Vegetation der Erde" In his most interesting conference "Engler and seine Zeit" (Botanische Jahrbuecher 102, 1981. PP. 21-38) F. A. Stafleu has given, at the occasion of the Tricentenary of the institution, a vivid description of Engler's era.

Since these lines are dealing with the history of the Botanic Garden proper it may be stressed here that many useful tropical plants and crops were propagated in the Dahlem gardens and then sent out into the satellite-gardens of the colonies (Amani in present Tanzania, Victoria (now Limbe) in Cameroon, Misahoehe and Sokode in Togo etc.]. According to I. Urban (in: Der koenigliche Botanische Garten und das koenigliche Botanische Museum zu Dahlem, Berlin 1909), the colonies provided also many plants for the glass-house-collections of the Botanic Garden in Dahlem.

The years between 1900 and 1914 may be called the "formative period" of the Dahlem Botanic Garden. The dimensions of this installation are rather impressive: 42 hectares of ground, divided into 13 hectares of plant geographical displays, another 13 hectares of woody plants collections (arboretum), 3 hectares for the plant systematic display area, the rest showing special collections like medicinal plants, water plants, useful plants and crops and a collection showing biological and morphological adaptations.

Original plan of the Botanic Garden and Museum Berlin-Dahlem showing the situation before the Second World War.

In addition there are 16 display glasshouses totalling 6000 square metres, amongst them the "Big tropical Glasshouse" with its impressive dimensions (60 m long, 30 m wide and 25 m high). The number of plant species in the glasshouses has been estimated at 9000. The open-air displays amount roughly to the same number so that 18,000 is the number of cultivated living plant species currently cited to form the scientific living collections of the Garden. To these numbers we may add another 1500 species and varieties of ornamental plants normally exhibited in the more decorative display areas (rose garden, ornamental annuals, ornamental perennials etc.).

The further development of the Botanic Garden Berlin-Dahlem was intimately linked with the political events since 1914: the First World War ended with the loss of the German colonies. The economic crisis after the war heavily affected the collections. In fact we know relatively few about the development of the living collections proper between 1914 and the Second World War. We may mention here the establishment of an important collection of living Rhododendron species in the Botanic Garden in connection with H. Sleumer's revision of the genus (Botanische Jahrbuecher 74, 1949, pp. 511-553), which is based upon this collection and the very important herbarium collections,

The present situation.

one of them being Schlechter's *Rhododendron* collection from New Guinea.

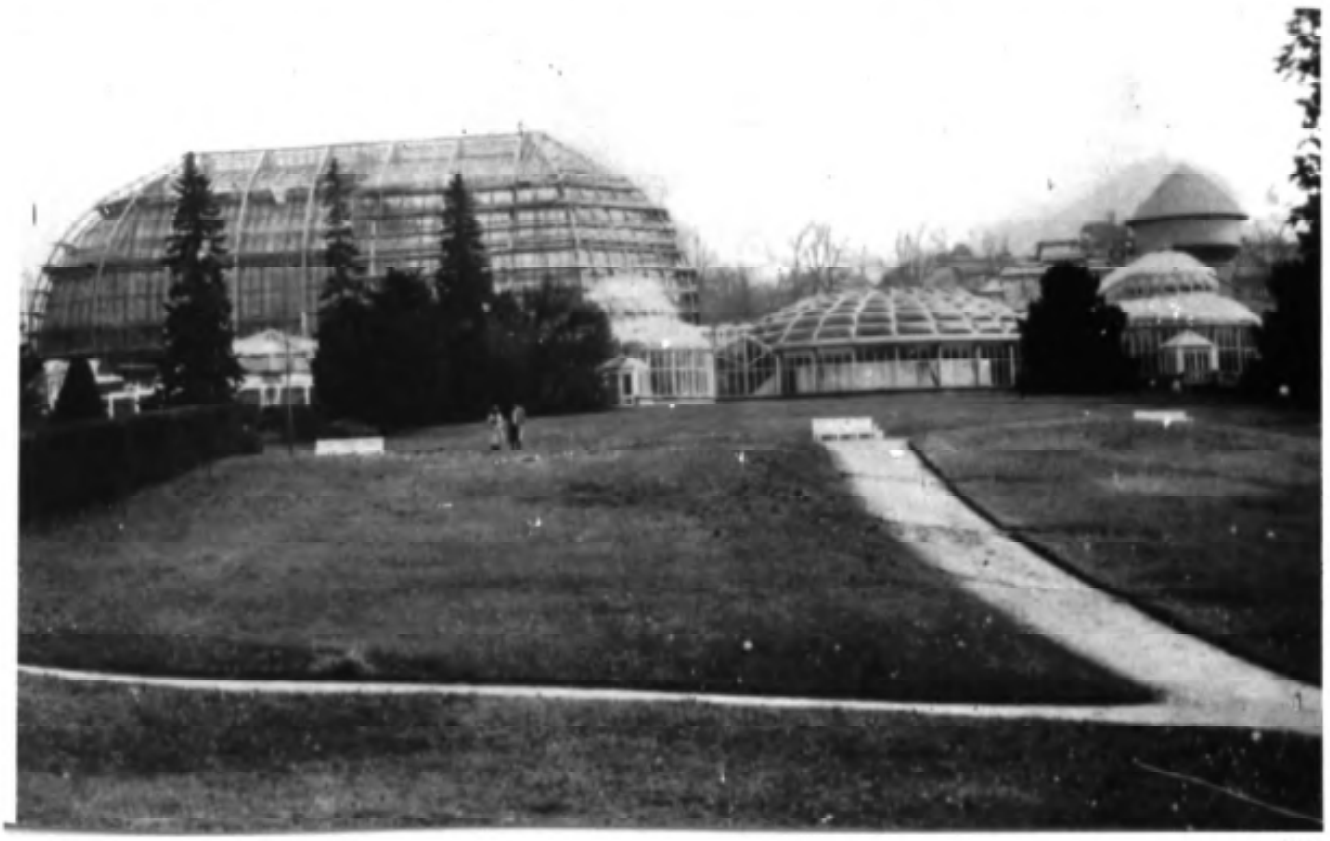
According to the overall state of the Botanic Garden Berlin-Dahlem between the two World Wars we may say that the living collections were maintained more or less in the form they had been laid-out during the formative period until 1914. Engler retired in 1921 and died in 1930. L. Diels, a specialist of East-Asian and Australian plants and a plant geographer, succeded as director of the institution. It became his fate to see the Botanic Garden and the Museum destroyed in the years 1943, 1944 and 1945. These destructions of the Second World War, the deaths of many of the staff members and the following catastrophic years for the city of Berlin affected the Botanic Garden very heavily.

The post-war period became an era of rebuilding and only in 1987 the Botanical Museum will become completely reconstructed. Alas this reconstruction will not repair the loss of more than 2 million herbarium specimens.

When W. Greuter became director of the institution in 1978, new research and collecting activities turned to the Eastern Mediterranean, especially to Greece. Consequently, very important living collections from this area have been built up in the Botanic Garden. The African tradition is maintained by some of the botanists of the institution who work on certain plant families for the "Flore du Cameroun" and the "Flore du Gabon", others join flora-projects in the Guianas and in the Indo-Pacific area. Before we deal with the actual state and the further development of the Botanic Garden Berlin-Dahlem, some general remarks have to be made :

A modern garden herbarium was established about 1952 by G. Schulze-Menz.

The big tropical glasshouse (left) together with the recently restored glasshouses.



who later became director-in-charge of the Botanic Garden. His successors continued to enlarge this indispensable tool of any scientific living plant-collection to its present size of about 25,000 specimens. The yearly additions to this garden-herbarium amount to about 2200 specimens.

Accession policy was shifted gradually towards wild-collected material. Today practically no seeds or plants enter the garden unless they are of well documented, preferably wild, origin.

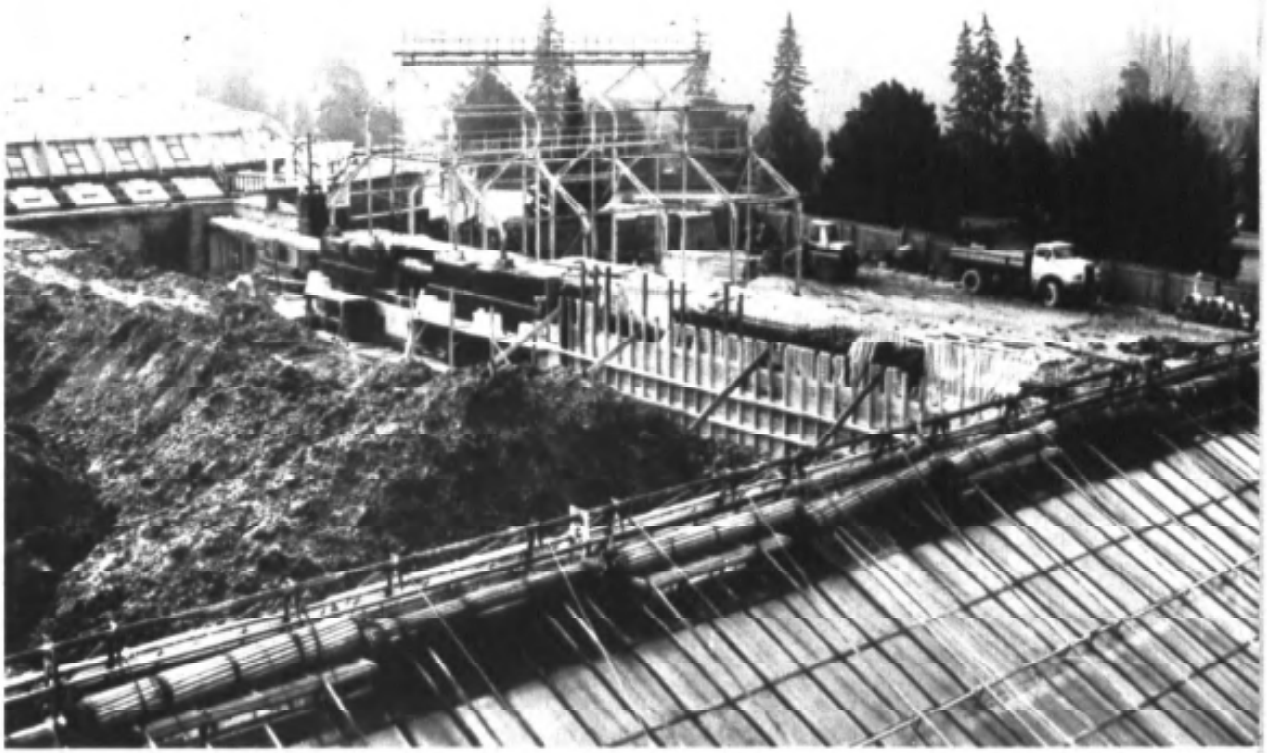
Accession-numbers were introduced which are now used for any accession made to the living collections (*see* B. Leuenberger: Scientific data recording in the Botanic Garden Berlin-Dahlem. Botanische Jahrbuecher 102 1981, pp. 133-134). Those trees and shrubs which are still without accession-numbers have got individual numbers.

The Index Seminum changed gradually from a list of seeds mainly collected in the Botanic Garden to a source of well-documented and scientifically controlled material, collected preferably in natural habitats all over the world.

Thanks to the joint effort of the staff of the Botanic Garden and of the Botanical Museum, most of those plant species found to be either misnamed or incorrectly placed have been either re-determined or removed.

Some of the famous plant geographical groups have been more or less completely revised. These are: the quarter showing plants from the mountains of the Iberian

Interior of the glasshouse for Tropical Ferns.



Demolition of the ancient glasshouses for Succulents. Actually these three houses are being restored.

Reconstruction of the Herbarium (underground) and the third wing of the Botanical Museum, the latter having been destroyed during the Second World War

Peninsula with the Pyrenees, the Balkan-Peninsula, the Anatolian-Caucasian-Iranian section and the 12 beds representing the vegetation of the Himalaya. There are plans to revise the remaining sections of the plant geographical section in due course.

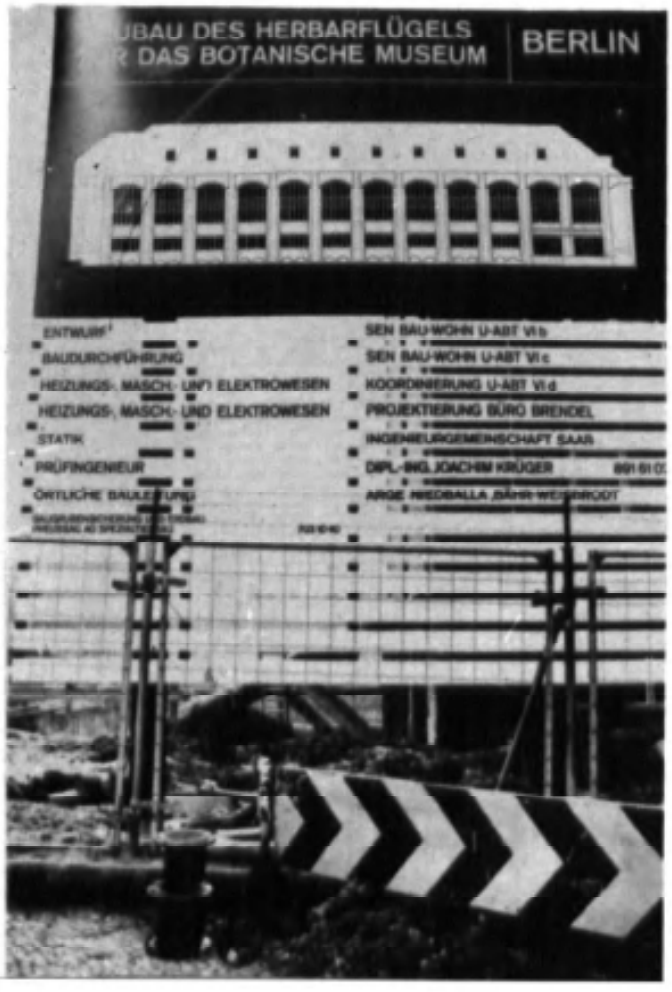
Other main activities of the post-war period have been :

The complete reconstruction of the display-glasshouses for the Bromeliaceae, the tropical fern-collection, the life-forms of Tropical Rain Forests, the tropical succulent collections and the South African plant collections.

The inauguration of a garden for the blind in 1984 : This new section covers 3000 square metres and shows 400 plant species which are not only labelled in the ordinary way but also with Braille-type labels. This section is much appreciated, not only by our blind visitors.

Aquilegia pyrenaica CD. —
one of the many endemics cultivated in the Plant Geographical Section.

Model of the new wing of the Botanical Museum Berlin-Dahlem.



The addition of many new service glasshouses to the older ones, thus bringing the under glass service area up to about 9200 square metres.

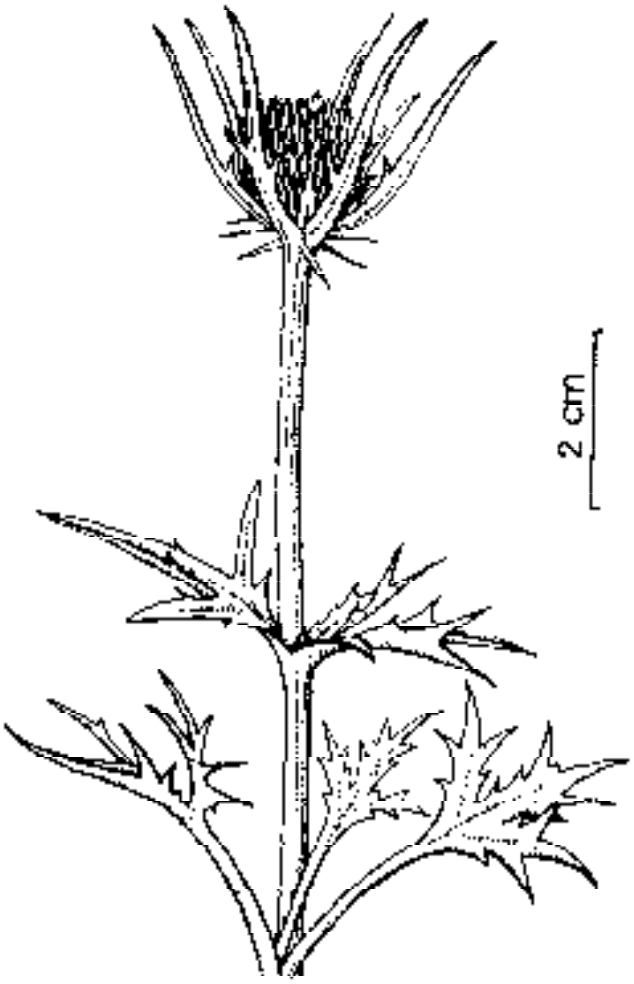
Together with the building and reconstruction activities preceding the next International Botanical Congress in Berlin (July 1987), many of the older installations are actually being modernized.

Finally we should mention the creation of a new section for endangered plant species and those plants which are being specially investigated by the botanists of the Botanical Museum.

Of the more spectacular plants endangered in the wild and held in the Botanic Garden Berlin-Dahlem we may mention here: Welwitschia mirabilis from Namibia and southern Angola, Lysimachia minoricensis from Menorca (Spain) or Adansonia grandidieri from Madagascar.

Ex situ conservation will be a much intensified field of work in the next years. The geographical and political situation of West-Berlin allow mostly for this form of participation in the world wide campaign to save the vanishing plant species of our globe. Consequently we are actually planning a modern seed bank and a laboratory to propagate orchids from seeds. A modern computer system is actually being planned as well. This will make it easier to administer the large holdings of living plants and to produce plant and seed lists, labels and all forms of information.

Finally, we want to intensify our public relations activities in order to increase the number of the visitors of the Botanic Garden and the display section of the Botanical Museum. Only if we can transmit the message of the beauty, the importance but also the fragility of our green heritage to as many people as possible, we will finally contribute substantially to the world-wide conservation activities in which Botanic Gardens of the world should play an ever increasing part !



Eryngium glaciale Boiss. —
a rare endemic from the Spanish Sierra Nevada. (Drawings by C. Hillmann-Huber)

NOTE : The historical data in this article have mostly been taken from the book. "Berlins Botanischer Garten" by R. Zepernick and E. M. Karlsson. Berlin 1979

KÓRNIK ARBORETUM

JAKUB DOLATOWSKI

Institute of Dendrology, Polish Academy of Sciences, Poland

Kórnik Arboretum, which belongs to the Institute of Dendrology of the Polish Academy of Sciences lies 20 km south of Poznań between the towns Kórnik and Śrem/Lat. 52° 15' N, Long. 17°06' E, Alt. 76-85 m/ in the valley of the Kórnik Lake. Kórnik lies in western Poland on the extensive Wielkopolska-Kujawy lowland. The climate is intermediate between an Atlantic one and a continental one, the winters being frequently mild and almost snowless and summers frequently dry. The total annual precipitation is 511 mm, average over many years. The absolute minimal winter temperature is −35°C. The arboretum covers an area of 60 ha. In recent years on a 5 ha area within the Institute experimental forest on the other side of the Kórnik Lake some new collections of coniferous trees and rhododendrons have been established.

The Arboretum was first established by the owners of Kórnik, Count Tytus Działyński and his son Jan. Starting in 1826 Tytus Działyński began to transform the garden existing in Kórnik into a landscape park with a collection of woody plants. The Kórnik Park quickly became one of the richest collection of introduced trees in Poland, counting about 1500 species. The last owner of the Kórnik estate, Władysław Zamoyski donated it to the nation and in this manner in 1925 a Foundation was established one of the purposes of which was to establish in Kórnik a scientific institution which would be concerned with dendrological research. The first director of the Ogrody Kórnickie/ Kórnik Gardens/ in the Foundation since 1926 was the well known horticulturalist and mycologist Antoni Wróblewski, who was responsible for the creation within 14 years of one of the richest dendrological collections in Europe and he began extensive breeding and acclimatisation work here. After the second World War the organisation of the ruined institution was placed in the hands of prof. Stefan Białobok who for many years became the director of the Dendrology and Pomology Department, since 1975 renamed the Institute of Dendrology. Since 1952 the Arboretum belongs to the Polish Academy of Sciences.

Presently the Arboretum is not an independent institution, but part of the Institute of Dendrology. The Institute is concerned with research in many fields biological sciences as related to woody plants/systematics and chorology, genetics of forest trees, biochemical genetics, physiology, particularly physiology of seeds and the problem of frost resistance, influence of injurious biotic and abiotic factors, anatomy/. The herbarium of the Institute has 50,000 sheets and besides native trees and shrubs includes a large collection of woody plants from south-west Asia and the Balkans. The Institute has also a Dendrological Museum. The Institute publishes an annual "Arboretum Kórnickie"

A view of the Arboretum during summer

The Arboretum was established by the owners of Kórnik Count Tytus Działynski

A view of the garden during snowfall

which publishes the works of its employees. Other publications include the monographic series "Our Forest Trees" and the "Chorology of Trees and Shrubs in South West Asia and Adjacent Regions". Also published is an Index Seminum which includes about 400-600 items exclusively trees and shrubs.

The dendrological collection has presently 3.000 species, varieties and cultivars. Of particular note are the rich collections of species and cultivars of the genus Malus, Populus and Syringa. During several decades of activity many new cultivars of ornamental trees and shrubs have been bred in Kórnik including Populus × wilsocarpa, Prunus × hillieri 'Kornicense' Thuja occidentalis 'Aurescens' and Thuja occidentalis 'Rosen' and numerous cultivars of yews, mock-oranges, lilacs and forsythias.

From May to October the Arboretum is open to the public and the number of visitors is approximately 100.000 p.a.

ALPINE BOTANICAL GARDEN SCHYNIGE PLATTE

BERNESE OBERLAND AND W. O. GIGON

Alpine Botanical Garden Schynige Platte, 3800 Interlaken, Switzerland

INTRODUCTION

In 1927 a private society was founded in Interlaken with the aim to create a refuge for endangered alpine plants. This refuge should further become a delightful display for the visitor, a place for scientific research and above all, a living museum for all friends of the alpine world. A site for this Alpine Garden the Schynige Platte above Interlaken was chosen. The plot adjoining to the railway station at 2000 m above sea level is surrounded by a magnificient panorama formed by the Bernese Alps with Eiger, Mönch and Jungfrau in the centre (Fig. 1). The garden could be opened to the public in 1929. Two years later a building could be inaugurated which included living quarters for the garden staff and a small laboratory with library for studies and courses in alpine botany.

Tall Forbs, in the background Eiger, Monch and Jungfrau

The garden society is able to maintain the Alpine Garden due to the entrance fees (more than 30.000 visitors per summer), contributions of the members, donations and some government support. Scientific staff members of the Systematic Geobotanical Institute of the University of Berne assist as scientific advisers.

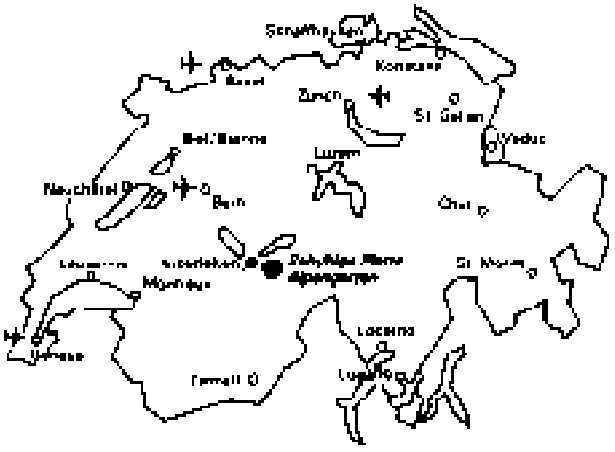
1983/84 the building could be renovated and enlarged due to substantial government support. It houses now a larger lecture room with library for courses. It contains also a permanent exhibition with details about local geology, alpine botany, zoology, ecology, etc.

The Schynige Platte with its Alpine Garden lies in the central part of Switzerland (Fig. 2 map of Switzerland).

The panoramic view of the area (Fig. 3) shows the means of access to the Alpine Garden. Wilderswil, at the foot of the Schynige Platte, can be reached by railway or road. From there, a rack railway brings the visitors in about one hour to the Schynige Platte. The entrance to the garden is at the end of the railway platform. The railway is in operation only during the summer season (May/June to mid October). The Alpine Garden is normally open from mid June to mid September. But sometimes the whole area is still snow-covered in June (cf. Fig. 4). Occasional snowfalls of up to 20 cm can occur in every summermonth. In spring we always find huge accumulations of snow in the depressions. Our 4 gardeners start their summer work early June mostly with cutting the paths through as much as 3-4 m of snow. Once disturbed, the remaining snow melts much faster.

Due to these climatic conditions the vegetation period and blossoming time have a duration of only about 4 months. The diagram in Fig 5 shows an average of flowering species, taken over a period of 8 summers (Itten, 1955).

Map of Switzerland



Switzerland | 4 000 000

THE ALPINE BOTANICAL GARDEN (MAP, FIG-3)

It covers an area of some 6300 square metres at an altitude between 1950 and 2000 m (6400-6560 feet) above sea level. Exposure is south to southeast. The average annual temperature is 1°C (34° F). During the vegetation period the average temperature reaches 8-9°C (47-48°F). Annual precipitation varies from 1600-2000 mm, of which 800-1000 mm are snow.

The geological subsoil of the garden consists mainly of limestones of Middle Jurassic age with marl intercalations and some loose blocks of Upper Jurassic limestone.

Acid rocks (granite and gneiss) for the Vegetation on Siliceous Soil had to be brought in from other parts of the Alps.

The garden shows the natural vegetation of the alpine and upper subalpine regions of the Swiss Alps. Of the 620 species known from these regions, more than 500

are present in the Alpine Garden. With exception of the Medical Plants in separate plots, the plants grow within their natural associations. Several of these associations were present before the garden was established. They form the base of the garden and have been supplemented by beautifully flowering swiss alpine plants which are not native to the Schynige Platte area.

The plants in the garden flower in natural sequence. A meadow shows first crocusses, is then covered by white anemones and finally turns yellow with buttercups.

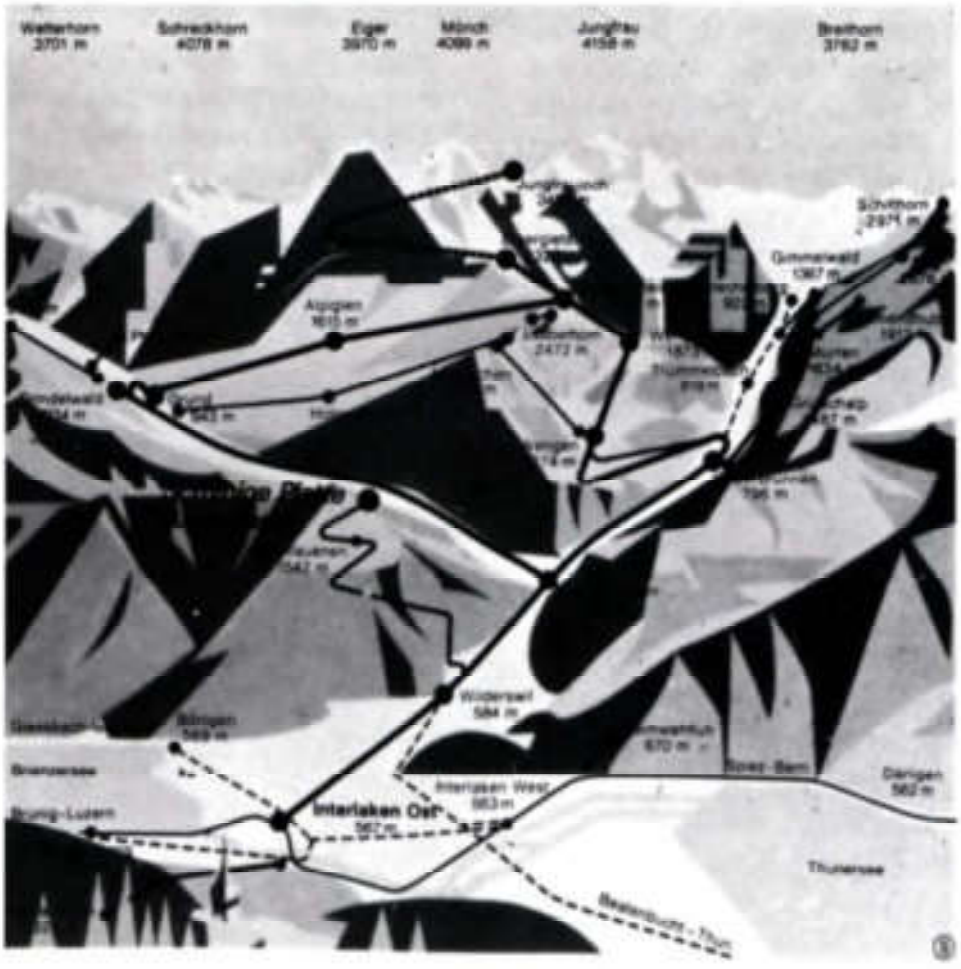
THE PLANT ASSOCIATIONS

The areal distribution of the various plant associations are given below. We also refer to Hegg, 1977 and Rvtz. 1956.

1. *Blue Sesleria Meadow*

The blue grass [Sesleria coerulea (L.) Ard.] occurs on steep, sunny south-facing slopes with calcareous subsoil. These slopes are the richest in flowers in the alpine and subalpine regions. On one square metre one can find more than 50 species of flowering plants. Small terraces are characteristic, as the blue grass and the evergreen sedge (*Carex sempervirens* Vill.) prevent erosion by trapping sand and fine gravel. The soil is very rocky and it tends to dry very quickly after rainfall. The plants of

Access of the Alpine Garden



this environment have good protection against excessive water losses.

Examples : a) dense hair coat (Leontopodium alpinum Cass.).
b) succulent leaves with a thick, waxy cuticle (Sempervivum).
c) leaves with borders rolled down to the mid-vein and therefore keep their stomata enclosed in a protected space during periods of drought (Erica carnea L.).

Typical plants of this association are :

Androsace chamaejasme Wulfen, *Aster alpinus* L., *Campanula thyrsoides* L., *Carduus defloratus* L., *Erica carnea* L., *Gentiana clusii* Perr. et. Song., *Helianthemum grandiflorum* (Scop.) Lam., *Leontopodium alpinum* Cass., *Pedicularis verticillata* L., *Potentilla crantzii* (Crantz) Beck.,

2. *Meadow of Rusty Sedge*

Lush grassy, natural meadows are often dominated by rusty sedges (*Carex ferruginea* Scop.). The calcareous soil is loamy and hardly ever dries out. This permits the growth of many different species. The slopes are normally too steep to be grazed by cattle. As they produce an excellent fodder, they were mown in earlier times. Nowadays this is rarely the case. This endangers the whole turf. The carpet of grass and leaves forms an easy sliding ground for avalanches. Furthermore, the covering snow might freeze to the turf and when becoming thick enough, slip away with the turf and the soil between

Schynige Platte early in June 1983

the roots. This type of erosion is very hard to stop or to reverse. Examples of this type of erosion can be observed in the neighbourhood of the garden and in many areas of the Alps.

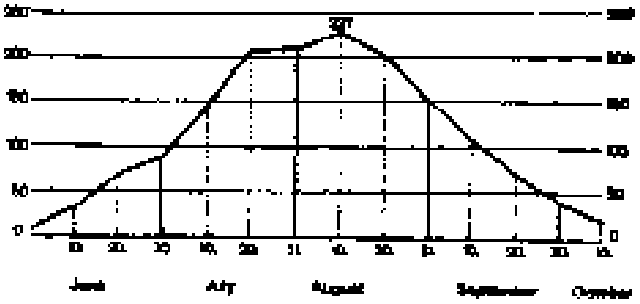
Characteristic species of this association are :

Anemone narcissiflora L., *Carex ferruginea* Scop., *Centaurea montana* L. *Crepis pontana* (L.) Dalla Torre, *Festuca pulchella* Schrader, *Pedicularis foliosa* L., *Phaca frigida* L., *Phleum hirsutum* Honckeny, *Puls atilla alpina* (L.) Schrank.

3. *Alpine Pasture*

The best cattle fodder in the alpine area is this dense, fresh green meadow on deep rich soil with a good water supply. It is mainly found on the more or less even areas of the Alps. Every summer the cattle is moved to these areas and this allows the pasture to be fertilized annually. There is less diversity in plant species than in the two associations described above. However, during full blossoming time this lush pasture offers a magnificent sight. Typical species

Number of flowering species summer season.



Alchemilla vulgaris s.l., *Crepis aurea* (L.) Cass., *Leontodon hispidus* L., *Ligusticum mutellina* (L.) Crantz, *Phleum alpinum* L., *Plantago alpina* L., *Poa alpina* L., *Trifolium badium* Schreber, *Trifolium pratense* L., *Viola calcarata* L.

4. *Mat-Grass Meadow*

The mat grass (Nardus stricta L.) with very tough leaves grows in dense tufts. Even sheep do not like to eat it, unless it is still young. It grows on poor and acid soil. Cattle eat only the herbs between the wiry grass bristles and herewith favour the growth of this "pasture weed". The mat-grass meadow is not productive. However, where the subsoil is not too poor, it can be transformed into an alpine pasture by application of fertilizer and lime. This was evidenced by experiments carried out in the surroundings of the Alpine Garden (*see* last chapter).

If grazing is stopped, this type of pasture is invaded by dwarf shrubs like huckleberry, bog-whortleberry, common heather, trailing azalea, rusty-leaved alpine-rose and after a long time even trees will dominate, if the meadow lies below the timberline.

The mat-grass is widespread on poor geological subsoil while in some places it is the result of excessive utilization (grazing). The plants growing with Nardus stricta contribute to a colourful picture when in full blossom. These are

Arnica montana L., *Campanula barbata* L., *Gentiana kochiana* Perr. et Song., *Gentiana purpurea* L., *Leucorchis albida* (L.) E. Meyer, *Pulsatilla sulphurea* (L.) DT. et Sarnth.

5. *Dwarf Shrub Heath*

Alpine areas which are not regularly used for grazing become overgrown by different dwarf shrubs, as already mentioned above. This would also be the case for the Schynige Platte area, if it would

not have been populated by grazing cows every summer since centuries. Today the dwarf shrubs are restricted to exposed ridges and steep slopes, which are not reached by grazing cattle.

Dryas octopetala L. and Rhododendron hirsutum L. are present in the Alpine Garden on places which are much like their natural habitat. They have only been slightly influenced by man. Dryas grows on shallow and stony soil on calcareous subsoil, while Rhododendron hirsutum prefers humus cushions in limestone debris and lapies. In the Alpine Garden it has selected the flat terraces in the calcareous rocks Besides the two mentioned species we find further : *Rhododendron ferrugineum* L., *Vaccinium myrtillus* L., *Vaccinium uliginosum* L., *Vaccinium vitis-idaea* L.

6. *Windy Ridge-Tops*

In this environment (Fig. 6) the plants face considerable mechanical stress due to strong and continuous wind. Furthermore, transpiration from the leaves is excessive. This microclimatic factor has forced many of these plants to develop hard and leathery leaves which have stomata on their interior side only. Others form dense carpets, like *Loiseleuria procumbens* (L.) Desv.

Windy Ridge-Top, in the background Wetterhorn and Schreckhorn

These plants exposed to strong winds are forced to be very hardy. In winter the snow is blown away. Gales dry up plants and soil and blow the tiny snow crystals along the leaves like a sandblaster. Furthermore, they have to resist very low temperatures without a protecting snow-cover and on sunny days, even in mid-winter, they may thaw while the water supply from the frozen subsoil is inaccessible.

Typical for this environment are the turfs of Elyna and the alpine Azalea-heath. In both associations many lichens are frequently found, as under these difficult environmental conditions they can compete particularly well with higher plants. Here we find : *Chamorchis alpina* (L.) Rich., *Elyna myosuroides* (Vill.) Fritsch, *Gentiana brachyphylla* Vill., *Lloydia serotina* (L.) Rchb., *Pulsatilla vernalis* (L.) Miller, *Silene acaulis* (L.) Jacq. (Fig. 7).

7. *Calcareous Rock*

Chemical conditions and weathering of the rock influence strongly the composition of the vegetation here. Even the position of layers is of importance. Plants prefer either rock, loose debris or turf. Typical rock plants like *Primula auricula* L., invade rocks first. They have long roots that enter deep into narrow crevices where they find some moisture even during very dry spells. The large, smooth leaves of *P. auricula* store nutritious components through the winter which enable them to produce flowers in early spring. During the summer they store water in their slime filled cells, a protection against dry periods. Their stomata have no particular protection. They are directly exposed to the air. Even the cuticle is rather thin. Therefore there must be internal physiological adaptations which prevent excessive evaporation.

Silene acaulis (L.) Jacq.

Typical plants on our calcareous rocks are : *Androsace helvetica* (L.) All., *Cystopteris fragilis* (L.) Bernh., *Dianthus silvester* Wulfen, *Draba tomentosa* Clairv., *Erinus alpinus* L. (Fig. 8), *Kernera saxatilis* (L.) Rchb., *Primula auricula* L., *Rhamnus pumila* Turra, *Saxifraga aizoon* Jacq., *Veronica fruticans* Jacq.,

8. *Calcareous Scree*

Fine soil on or near the surface of a stony slope is as rare as on the rocky walls. Here the plants need a wide spreading root system which reaches down to the fine soil and moisture. The vegetation has to resist mechanical damage caused by tumbling rock pieces and the slow movement of the upper part of the scree. Many of the species are well adapted to these special circumstances. In these seemingly bare and rocky deserts they produce a nice loose cover the striking and colourful flowers : *Campanula cenisia* L., *Cerastium latifolium* L., *Doronicum grandiflorum* Lam. (Fig. 9), *Hutchinsia alpina* (L.) R. Br., *Linaria alpina* (L.) Miller, *Moehringia ciliata* (Scop.) Dalla Torre, *Papaver alpinum* L., *Papaver aurantiacum* Loiseleur, *Ranunculus glacialis* L. (Fig. 10) *Ranunculus Seguieri* Vill., *Senecio doronicum* L., *Sieversia reptans* (L.) R. Brown, *Thlaspi rotundifolium* (L.) Gaudin, *Valeriana montana* L. *Ranunculus glacialis* is one of the flowering plants which reaches highest in our Alps. At the Finsteraarhorn (highest peak in the Bernese Alps) it is found up to the top at 4275 m (14016 feet), Schroeter, 1908.

In our Alpine Garden the scree is artificial. The natural mechanical influences which would keep the vegetation in check is missing. Our gardeners therefore have to watch, that grass from neighbouring pastures does not intrude into the scree.

Plants on calcareous rocks

9. *Vegetation on Siliceous Soil* (Fig. 11)

Representatives of the group of plants which grow on acid soil were almost lacking in the Schynige Platte area. With exception of some slightly sandy limestones and some shales the area consists of calcareous rocks only. More than 40 tons of granite, granite sand and gravel and gneiss were brought in from other parts of the Alps to serve as subsoil for the plants which grow only on siliceous soil. Here the lovely flowering plants of the granite massifs of the central Swiss Alps were planted and many of them grow now in their natural associations. The following associations have been set up artificially (they have not yet fully attained their characteristic compositions) : *Caricetum curvulae, Salicetum helveticae, Oxyrietum digynae, Salicetum herbaceae.* Out of the rather rich and colourful flora we would like to mention : *Androsace alpina* (L.) Lam., *Campanula excisa* Schleicher, *Carex curvula* All., *Centaurea rhaponticum* L., *Chrysanthemum alpinum* L., *Dianthus glacialis* Hänke (Fig. 12).

Doronicum grandiflorum L.

Gentiana pannonica Scop. (Fig. 13), *Gentiana punctata* L., *Saxifraga bryoides* L., *Sempervivum arachnoideum* L., *Sempervivum wulfenii* Hoppe.

10. *Snow Combe Vegetation*

Under the term "Snow Combe" we understand gently sloping hollows in which the snow remains for relatively long periods. The melting snow keeps the soil damp. Fine earth, mineral dust and organic detritus accumulate in these depressions, producing a soil rich in nutritive substances. The plant associations growing here are characterized by their adaptation to an extremely short vegetation period. The plants develop thick underground stems or fleshy roots where food substances can be stored. This allows them to prepare for the time of vegetation even under the snow cover. In this way they are ready for flowering as soon as the snow has melted. These plants are in general rather small. Many of these plants are very sensitive to the quantity of calcareous material contained in the soil.

In *calcareous Snow Combes* we find as typical plants : *Arabis coerulea* All., *Gentiana bavarica* L., *Saxifraga androsacea* L., *Saxifraga stellaris* L.,

Characteristic for *Snow Combes on acid soil* are : *Alchemilla pentaphyllea* L., *Carex foetida* All., *Cerastium cerastioides* (L.) Britton, *Gnaphalium supinum* L., *Salix herbacea* L., *Soldanella pusilla* Baumg.

11. *Alpine Bog*

In the area of the Alpine Garden with the rather porous rocks there is no depression which keeps rainwater. Therefore

Ranunculus glacialis L.

we had to create artificially a tight depression for the Alpine Bog. After digging a basin of about 1 m depth we covered the bottom with sheets of plastic felt to serve as protection against digging mice. On top of this we spreaded a plastic foil which was extended under the neighbouring area in order to catch more rainwater. The basin was then filled with a 50-50 mixture of peat and loess. In spring the water of the melting snow creates good starting conditions for the summer. Even with only occasional rainfall as during the summer of 1985 the bog did not dry out. For the time being the main species are : *Caltha palustris* L., *Comarum palustre* L., *Eriophorum angustifolium* Honckeny, *Eriophorum Scheuchzeri* Hoppe, *Menyanthes trifoliata* L., *Swertia perennis* L.

12. *Scrub of Green Alder*

The green or alpine alder [*Alnus viridis* (Chaix) DC.] and the mountain fir (*Pinus montana* Miller) easily grow on avalanche slopes. The snow bends the flexible stems onto the ground and the avalanches glide over them without causing much harm. In spring they become again erect. They do not represent barricades against avalanches, but they are very useful as their roots hold the soil. These shrubs therefore prevent excessive erosion on steep slopes.

The alpine alder has little nodules on its roots which contain a fungus Actinomyces. This fungus is able to assimilate nitrogen from the air and to make it available to higher plants. This fact enables the alder to become even a "pioneer-shrub". It may also thrive on barren soil and can increase its nitrogen content. Therefore, some plants which normally grow only on good and rich soils can sometimes also be found under scrubs of the green alder. These are mainly the same as those found in the Tall Forbs (chapter 13). In addition to these we find particularly : *Aquilegia alpina* L. (Fig. 14) and *Cortusa matthioli* L.

Part of the Vegetation on Siliceous Soil

13. *Tall Forbs*

The typical Tall Forbs are found in moist and shady valleys and in hollows where fine earth has accumulated in thick layers and where in spring snow lasts longer and therefore keeps the soil damp. This plant association develops well in naturally wood-free areas below the timberline. Smaller groups can reach up to about 2200 m (7000 feet) above sea level. Due to the rich supply on nutrient the vegetation is normally very productive. Within the short mountain-summer these plants grow to a height of 3-4 feet and flowers and seeds are produced. During the winter all the plant material, except the main stalks, decays into humus or becomes completely mineralized. In spring Soldanellas and Primroses appear between the young, often nearly flower like, red sprouts of the Tall Forbs. After the spring flowers *Soldanella alpina* L. and *Primula elatior* (L.) Hill the typical species of this association develop : *Achillea macrophylla* L., *Aconitum lycoctonum* L., *Aconitum napellus* L., *Aconitum paniculatum* Lam., *Adenostyles alliariae* (Gouan) Kerner, *Cicerbita alpina* (L.) Wallr., *Delphinium elatum* L., *Eryngium alpinum* L., *Saxifraga rotundifolia* L., *Senecio nemorensis* L., *Thalictrum aquilegiifolium* L.

In free nature *Eryngium alpinum* L. is one of the vulnerable species for Switzerland and Europe, but in our Alpine Garden it grows abundantly.

Dianthus glacialis Hänke

14. *Nitrophilous Vegetation*

This vegetation is mainly found around alpine huts and other places where cattle or game rest to ruminate or remain for shelter. Here manure is deposited in large quantities. The result of this heavy fertilization is a characteristic plant association of fleshy and fast growing species with often large leaves. Cattle normally ignore this type of vegetation.

In the Alpine Garden, where cattle of course has no access anymore, this association of nitrophilous plants must be fertilized regularly. To give the soil the necessary surplus of nitrogen, cow-dung from the neighbouring alp is spread over this part every autumn.

The characteristic species of this association are : *Aconitum napellus* L., *Chenopodium bonus-henricus* L., *Cirsium*

Gentiana pannonica Scop.

spinosissimum (L.) Scop., *Gagea fistulosa* (Ram.) Ker-Gawl., *Polygonum bistorta* L., *Ranunculus aconitifolius* L., *Rumex alpinus* L., *Rumex arifolius* All., *Senecio alpinus* (L.) Scop.

The ground between these tall herbs is mainly covered by *Alchemilla vulgaris* L.

15. *Medical Plants*

"For this part we cite the text of our official guide (Hegg, 1977). "Quite a number of alpine plants were used and are still used today in Folk Medicine Some of them are dangerously poisonous, for instance the common monk's-hood, which contains the alkaloid "aconitin". Their active substances are only effective when administrated by a doctor in proper dosage. Others are merely aromatic herbs which are used for infusions and alcoholic extracts. The difficulties surrounding collecting some of them on rocky walls and dangerous edges, may add to their medical efficiency. In other cases, ancient

Aquilegia alpina L.

naturalists deduced from the shape of leaves or roots on what human organ they should be applied. But for many species the active substances are well known. Among those species which are sought for "Folk Medicine" are: silver lady's-mantel; yellow and purple gentian, big masterwort, common cat's foot, iceland moss *(Alchemilla conjuncta, Gentiana lutea* and *Gentiana purpurea, Astrantia major, Antennaria dioica, Cetraria islandica)* and the alpine worm-wood species *Artemisia genipi* and *Artemisia mutellina* which are protected throughout Switzerland.

The cultivated areas in the Alpine Garden show how difficult it is to grow a plant in the alpine zone when the surrounding conditions do not completely meet its demands. While arnica, huckleberry, and purple gentian etc. do very well on the places in the garden which are suited for them, they are in bad condition when cultivated and hardly ever flower."

THREATENED AND RARE VASCULAR PLANTS OF SWITZERLAND

Of the plants cited in the RED DATA BOOK for Switzerland (Landolt *et al.*, 1982) the following are present in our Alpine Garden :

Endangered species :

Achillea clavenae L., *Gentiana pannonica* Scop. (Fig.13), *Ranunculus segueri* Vill.

Vulnerable species :

Aquilegia alpina L. (Fig. 14), *Asphodelus albus* Miller, *Cypripedium calceolus* L., *Eryngium alpinum* L., *Gentiana cruciata* L., *Lilium bulbiferum* L.

Rare species :

Aconitum anthora L., *Alyssum alpestre* L., *Androsace brevis* (Hegetschw.) Cesati, *Androsace villosa* L., *Aquilegia einseleana* F.W. Schulz, *Artemisia glacialis* L. *Astragalus sempervirens* Lam.,

Lychnis flos-jovis (L.) Desr.

Cephalaria alpina (L.) Schrader, *Cicerbita plumieri (L.)* Kirschleger, *Cortusa matthioli* L., *Dianthus glacialis* Hänke (Fig. 12), *Dracocephalum ruyschiana* L., *Lychnis flos-jovis* (L.) Desr. (Fig. 15), *Papaver rhaeticum* Leresche, *Papaver sendtneri* Kerner, *Saponaria lutea* L., *Sempervivum grandiflorum* Haw., *Sempervivum wulfenii* Hoppe.

Attractive species :

Allium victorialis L., *Androsace carnea* L., *Androsace helvetica* (L.) All. *Androsace lactea* L., *Androsace vandellii* (Turra) Chiov., *Artemisia genipi* Weber. *Artemisia mutellina* Villa., *Centaurea rhaponticum* L., *Clematis alpina* (L.) Miller, *Delphinium elatum* L. *Eritrichium nanum* (Amann) Schrader *Gymnadenia conopea* (L.) R. Br., *Leontopodium alpinum* , Cass. *Lilium martagon* L., *Nigritella nigra* (L.) Rchb., *Orchis globosa* L. *Orchis mascula* L., *Paradisia liliastrum* (L.) Bert., *Primula auricula* L.

SEEDS

We collect seeds in the Alpine Garden and in the neighbouring mountain area. These seeds are offered to Botanical Gardens through the Index Seminum of the Botanical Garden of the University of Berne.

SCIENTIFIC RESEARCH AND EXPERIMENTS. TEACHING

The alpine flora and the plant associations of the Schynige Platte (including the area on which the Alpine Garden was established) has been studied in detail before and during the early years of our Alpine Garden (Lüdi, 1948). He also observed the ecological factors and the succession of the associations within the Garden (Lüdi, 1939).

In 1930 the same author established 340 test surfaces of one square metre

each in a Sieversio-Nardetum near the Alpine Garden. He wanted to investigate, under which conditions this rather non-productive meadow could be transformed into an alpine pasture. From a part of the squares the vegetation was completely removed. On a certain number of these he sowed a seed mixture collected in the area. To all squares different fertilizers were applied. First results were published by Lüdi in 1959.

Then Dr. O. Hegg of the System.-Geobot. Institute of the University of Berne investigated the test surfaces again in 1971 and 1982. Clear evidence was found, that 50 years after establishing the squares and 25 years after the last fertilization, the differences between the squares are still clearly visible (Hegg, 1984 A and B). The combination of N, P and K promotes the foodplants, Ca brings a diminution of acidophilous species and after a time lag promotes the foodplants like a complete fertilization with NPK. The combination of all 4 produces the greatest and most lasting effects.

Teaching : Every year staff of the System.-Geobot. Institute of the University of Berne organise courses in Alpine Botany, mainly for students.

ACKNOWLEDGEMENTS

I am deeply indebted to Dr. O. Hegg (University of Berne) for his advice and help during the preparation of this paper and for all his advices we receive for our Alpine Garden.

REFERENCES : Hegg, O. Guide to the Alpine Botanical Garden at Schynige Platte. 1977

Hegg, O. Long-term-influence of Fertilization on Some Species of the Nardetum at the Schynige Platte above Interlaken. Angew. Botanik 58. 141-148. 1984 A. ISSN 0066-1759

Hegg, O. 50-Jähriger Wiederbesiedlungsversuch in gestörten Nardetum-Flächen auf der Schynigen Platte ob Interlaken. Diss. Bot. 72. 459-479. 1984 B.

Itten, H. The Alpine Garden of Schynige Platte. Swiss Homeland Books. P. Haupt. Berne 1955.

Landolt, E., Hess, H. E. and Hirzel, R. Flora der Schweiz. 3 Vol., Birkhäuser. Basel. 1967-1972

Landolt, E. et al. Report on threatened and rare vascular plants of Switzerland. Red data Book. Ber. Geobot. Inst. E.T.H., Stiftung Rübel. 49. 195-218. 1982

Lüdi, W. Veränderungen der Dauerflächen in der Vegetation des Alpengartens Schynige Platte innerhalb eines Jahrzehntes 1928/29 bis 1938/39. Ber. Geobot. Inst. Rübel (1939). 93-146. 1940

Lüdi, W. Die Pflanzengesellschaften der Schynigen Platte bei Interlaken und ihre Beziehungen zur Umwelt. Eine vergleichend ökologische Untersuchung. H. Huber. Bern. 1948

Lüdi, W. Versuche zur Alpweidverbesserung auf der Schynigen Platte. Published with the Annual Report of the Alpine Garden Schynige Platte. 1959

Rytz, W. Guide to the Schynige Platte Alpine Garden. Berne. 1956

Schröter, C. Das Pflanzenleben der Alpen. Zürich. 1908

THE ROYAL HORTICULTURAL SOCIETY'S GARDEN

P. J. MAUDSLEY

The Royal Horticultural Society's Garden, Wisley, Working, Surrey U.K.

WISLEY first began to take shape as a garden over a hundred years ago, when a sixty-acre estate was purchased by Mr George F. Wilson, a former Treasurer of the Royal Horticultural Society.

Wilson, who was one of the most skilled amateur gardeners of his day, made the first plantings at Wisley in 1878. He was quick to see the possibilities of the oak wood near the western boundary, and the Wild Garden he made there soon became famous. He also planted shrubs and lilies on the rising ground to the south of the Wild Garden, and established Japanese irises and other waterside plants by the margins of ponds he had constructed.

After Wilson's death the estate was purchased by Sir Thomas Hanbury, and in 1903 was given by him in trust for the perpetual use of The Royal Horticultural Society 'for the purpose of an Experimental Garden and the Encouragement and Improvement of Scientific and Practical Horticulture in all its branches'

The present functions of Wisley, based on the terms of this trust, may be briefly summarised as: (1) to maintain a garden where Members of the Society and other visitors may see growing as full a range as possible of ornamental plants; (2) to provide advice to Members on horticultural problems; (3) to carry out trials and maintain collections of new varieties of flowers, fruit and vegetables; (4) to train young gardeners in the practice of horticulture; and (5) to carry out scientific investigations and research work in horticulture and related sciences

In the spring of 1904, the centenary year of the Society's foundation, Mr S. T Wright came as Superintendent to Wisley from Chiswick, where the Society had occupied a garden for over eighty years, and under his supervision development of the Garden began at once.

In 1907 F. J. Chittenden was appointed Director of the Laboratory, and in 1914 Dr (later Sir) Frederick Keeble, F.R.S., came to Wisley as Director of the Garden.

Dr Keeble was followed as Director by F. J. Chittenden, F.L.S., V.M.H., 1919-31; R. L. Harrow, V.M.H., 1931-46; J.S.L. Gilmour, M.A., F.L.S., V.M.H., 1946-51; Dr H. R. Fletcher, D.SC., PH.D., F.R.S.E., V.M.H., 1951-54; F. P. Knight, F.L.S., V.M.H., 1955-69; and C. D. Brickell, B.SC., V.M.H.(Director General of the Society in 1985); and P.J.Maudsley B.Sc. F.L.S. was appointed Director in 1985

The area under cultivation in 1904 did not greatly exceed six acres, but it has gradually been extended until at the present time practically the whole of the original estate, as well as additional areas at the north and south ends, purchased at later

*Courtesy From the Guide to Wisley Garden

dates, is laid out with ornamental plants, fruit and vegetables. The total area of the Society's property at Wisley is now 300 acres, of which the Garden covers about 250 acres, the remainder consisting of farm, woodland and the village of Wisley.

The approach road to Wisley Garden from the main London—Portsmouth road runs through a part of Wisley Common, an undulating tract of country thinly wooded with Scots pine, birch and oak.

The soil at Wisley is very sandy, quick-draining and acid in reaction. Although a small seam of clay runs through one part of the Garden most areas are lacking in humus and nutrients. Frosts are frequent and often severe and may be expected at least until the end of May or early June each year, while the average annual rainfall is only 26 in. (660 mm). In these somewhat difficult conditions, it is necessary to mulch,

The Laboratory and offices

feed and water the plants well to achieve good results.

In 1921 in order to help gardeners in choosing the best plants to grow, the RHS Council established the Award of Garden Merit for plants which have proved their worth in British gardens and are generally available in the nursery trade. Originally plants given this award were grown in a separate area of the Garden but, as over 1,000 plants have now received the award, it is not possible to accommodate them all in one area and many are now incorporated into planting schemes in other parts of the Garden.

The view of the frontage with ponds flower gardens

BROOKGREEN GARDENS, A SOCIETY FOR SOUTHEASTERN FLORA AND FAUNA

GURDON L. TARBOX, JR. AND ROBIN SALMON

Brookgreen Gardens, Murrells Inlet, South Carolina 29576 (803) 237-4218

Brookgreen Gardens is a unique organization presenting three distinct collections that form an unusual concept. The combination of botanic, wildlife and artistic aspects creates a pleasing collaboration between native plants, animals and American sculpture. In a historic sense, Brookgreen is a descendent of the gardens of antiquity. Yet, it has its own peculiar flavor and style which sets it apart from most botanic gardens, wildlife sanctuaries and art museums. Part of the singularity of Brookgreen Gardens stems from its composition: it stretches from the Atlantic Ocean to the Waccamaw River and encompasses a variety of biota and habitats. Its uniqueness also stems from its position as an undeveloped tract isolated by commercial and residential development. The founders of Brookgreen Gardens foresaw this phenomenon, safeguarded the property through legal channels and attempted to preserve its natural state through a minimum of development. Many outstanding individuals were associated with the building of the Gardens and acquisition of plant collections.

The 300 landscaped acres of Brookgreen Gardens' grounds, open to the public on a regular basis, comprise a botanic garden exhibiting over 2,000 taxa situated on a part of a 9, 127 acre tract which forms a wildlife sanctuary.

Part of the property, yet operated as a separate entity, is Huntington Beach State Park, comprised of 2,500 acres. This land owned by Brookgreen Gardens was leased to the State of South Carolina at no cost in 1960. Characterized by beach, salt marsh and maritime forest plant communities, it serves as a habitat for numerous species of plant and animal life. Portions of the property have been registered under the South Carolina Heritage Trust Program which designates significant areas of land for preservation of scenic and unusual biological features. Colonies of *Amaranthus pumilis* (Sea-Beach Pigweed), a Least Tern nesting area and an undisturbed beach-dune-estuary ecosystem are protected by this designation. *Amaranthus pumilis* is listed as threatened throughout its range in the United States according to the Heritage Trust Program of the South Carolina Wildlife and Marine Resources Department.

The developed portion of Brookgreen Gardens is divided into three major areas (1) the sculpture gardens, (2) the wildlife park, and (3) landscaped expanses which connect the gardens and wildlife park.

The sculpture gardens include a ten-acre open-work brick-walled area divided into smaller gardens emphasizing certain landscape features and plant types. For example, the Dogwood Garden, a square blocked formal garden, is lined with 100 mature specimens of *Cornus florida* creating a breathtaking scene in the spring and a shady retreat in the summer. The

Palmetto Garden features rectilinear walkways bordered with South Carolina's state tree, *Sabal palmetto*. The Live Oak Allée is a majestic remnant from the days when Brookgreen was a thriving rice plantation. These massive specimens of *Quercus virginiana*, approximately 225 years old, average 50 feet in height and exhibit a wide-spreading crown. Some branches may extend over 100 feet in length. Brookgreen Gardens has a significant collection of native trees which are exhibited across the entire grounds. Included are magnificent specimens of hickories *(Carya)*, oaks *(Quercus)*, magnolias *(Magnoliaceae)*, buckeyes *(Hippocastanaceae)*, dogwoods *(Cornaceae)*, hollies *(Ilex)*, beech *(Fagaceae)*, waxmyrtles *(Myricaceae)*, and cypresses (*Taxodium*).

Brookgreen Gardens is a refuge for common and rare, threatened and endangered plants. South Carolina presently has just over 3,000 different species or subspecies of native and naturalized vascular plants. Almost 300 are considered rare, threatened or endangered, representing nearly 10% of the state's native flora. Habitat modification or destruction is the greatest potential threat to rare plant species. Today, Brookgreen Gardens' preservation of habitat from the Atlantic Ocean to the Waccamaw River, covering several distinct plant communities, is one of its major purposes. Located in a rapidly developing resort region, Brookgreen Gardens is becoming the last green space along this portion of South Carolina's coast.

Brookgreen Gardens, a Society for Southeastern Flora and Fauna, was founded in 1931 to exhibit and preserve works of art, animals native to the Southeastern United States, and indigenous Southeastern plants with selected exotics suitable for this climate.

The original purpose of the plant collection was not only to cultivate plants of the Southeastern United States to be identified and studied by plantsmen and the public, but to enhance the beauty of the grounds and sculpture collection. A primary feature of the sculpture gardens is the cooperative interplay between the land-scaped settings and the art works. It is not always clear whether the setting showcases the sculpture or whether the sculpture enhances the landscape, what appears to be ambiguous actually is quite deliberate. This is the key to Brookgreen Gardens' success as the country's major sculpture garden. By the late 1930s, the basic design of the gardens as conceived by the founders was completed. In later years additional garden areas were laid out to complement the existing design and accommodate expanding plant and sculpture collections.

The assemblage and identification of the numerous indigenous plants was the accomplishment of Frank Green Tarbox, Jr., Brookgreen's first horticulturist and director. He was assisted by such distinguished botanists and horticulturists as John Kunkel Small and E. J. Alexander of the New York Botanical Garden, Clarence E. Kobuski and Alfred Rehder of the Arnold Arboretum, and Sidney Fay Blake, Senior Botanist, United States Department of Agriculture.

In South Carolina, David R. Coker of Coker Pedigreed Seed Company, a noted plantsman and agricultural scientist, and his wife, May Roper Coker, contributed plant materials and expertise to the effort. Numerous regional plant experts, enthusiasts and local property owners provided additional assistance and information. Professor M. A. Rice of Clemson College (now Clemson University), the state's agricultural and technical school, helped with identification. Professor W. C. Coker of the University of North Carolina at Chapel Hill cooperated by exchanging plants and information.

In later years, Professors H. Roland Totten and Hugo Leander Bloomquist of the University of North Carolina at Chapel Hill provided invaluable assistance in identification and location of vascular plants. More recently, Harriet Prince, a noted regional wildflower authority, has contributed seed, cuttings, plants, expertise and books from her personal library to Brookgreen Gardens.

During the 1930s, Frank Tarbox was busily collecting plants, cuttings and seed on weekly Saturday field trips, not only for Brookgreen Gardens, but for exchange with other botanical gardens and arboreta. Many rare specimens, along with those having critical growth requirements, were included in the collection. It is interesting to note that printed observations made by Frank Tarbox fifty years ago relative to plant rareness and uniqueness are often valid in 1986. He recorded the activities of Brookgreen Gardens' development in a weekly report to its founder and president, Archer Milton Huntington. Cooperation between Tarbox, local plantsmen, and national plant experts is evident during these early years. Tarbox wrote to Huntington on 15 November 1933

> "We have had a couple more good since I wrote to you last, so I shall not get to gather more small plants this fall. Of the two *Ibidiums*[1] I sent to the New York Botanical Gardens last week, *I. longilabre*[2] has not been reported north of Florida before. Dr. Small[3] has sent me some seed of a rare plant he rediscovered in Mississippi, *Amsonia ludoviciana*[4]. It has bluish flowers and a rather long flowering season...."

Amsonia ludoviciana still thrives at Brookgreen Gardens although it is now rare in its native habitat in Mississippi, Arkansas and Louisiana.

In May 1934 Frank Tarbox described his visit to the home of Mr. and Mrs. David Coker in Hartsville, South Carolina. May Coker showed him the garden she was then creating which today is known as Kalmia Gardens.

> "....Aside from the gardens around their home in Hartsville, I got to see the Garden she is making about two miles out of town, and this place is most interesting. Comparatively high hills slope toward a small creek leaving an amphitheater like depression, with the hills rising on three sides....At present the Mountain Laurel[5] is the predominating flower. Really, the whole 57 acres is nature's garden, which Mrs. Coker is opening up and making more beautiful. It will be the showplace of that section of the state..."

Tarbox received from the Cokers' garden several plants including *Shortia galacifolia* and *Stewartia ovata*. The *Shortia* is now threatened in South Carolina and is a candidate for federal listing as endangered or threatened. *Stewartia ovata* is listed as threatened regionally or throughout a significant portion of its range.

In June 1934 Tarbox noted

> "....I have located a group of Venus Fly-trap, *Dionaea muscipula*, just about two miles south of Socastee..."

Today, in this region *Dionaea muscipula* grows in habitats which are being paved over for condominium parking lots or redesigned for golf courses and other recreational activities. Its status is listed as threatened in the state. Brookgreen Gardens has had difficulty in transplanting specimens rescued from the developer's machinery, many of the plants do not survive. Local members of the National Audubon Society have aided preservation

efforts by locating significant plants in areas scheduled for development and contacting Brookgreen Gardens' staff to make arrangements for collection. One local developer even offered to allow staff to collect plant materials prior to the onset of construction. This cooperative spirit demonstrates that there is a common ground on which developers and preservationists can meet.

A Wildflower Savannah established in the remote southern portion of Brookgreen's property in the late 1970s has been the most frequent transplant site of *Dionaea muscipula* although some specimens are exhibited in the native wildlife park along with *Sarracenia flava*,[6] another indigenous carnivorous plant. The Savannah is a low area, flooded in wet seasons, dominated by stands of Longleaf Pine *(Pinus palustris)* that is burned every few years to provide a habitat suitable for the growth of wildflowers.

Two other significant indigenous plants became part of the collection in the early period: *Pinckneya pubens* (Fever-tree) and *Elliottia racemosa* (Georgia Plume). John Kunkel Small of the New York Botanical Garden sent a small quantity of seed to Tarbox which was planted in flats and flower pots. Todays, Brookgreen Gardens propagates *Pinckneya* in its greenhouse facilities. Although it is threatened on the state level, it has been propagated with success here and is available for exchange with other botanical facilities. *Elliottia* is listed as having been extirpated from South Carolina, although there are a few specimens at Brookgreen acquired from a cooperator in Savannah, Georgia. In January 1937 Frank Tarbox prophetically wrote

> "...*Elliottia racemosa, Pinckneya pubens, Benzoin australe*, and *Benzoin melissaefolium*[7] ....have been set out in the Gardens. The first and last named I would like to, some time, get established in the woods, for they are scarce and to botanists will some day be of much greater interest...."

Lindera melissaefolium, known locally as Jove's Fruit, today is considered endangered throughout its range in the United States. Brookgreen Gardens has an individual specimen.

Brookgreen Gardens' role in an urbanizing region is to make efforts to duplicate natural habitats so that plants displaced in the wild can be relocated here. The practice of collecting plants through field trips is not always satisfactory today in terms of cost; plants in their wild state are becoming increasingly rare and property ownership must be respected. Cooperation among local developers, natural history enthusiasts and plantsmen is necessary to ensure that habitat modification does not eradicate plant species. To a certain extent, this cooperative effort has enabled Brookgreen Gardens to acquire both rare and common specimens that can be propagated for distribution or exchange.

In recent years Brookgreen Gardens has provided plants, seeds, leaves, and roots to medical, academic and industrial sources for experimentation. This aspect and use of the plant collection benefits humanity through medicinal and scientific applications. Since Brookgreen Gardens was not founded to conduct scientific research of its own, this utilization of the collection through cooperation with other research facilities performs an important public service.

Brookgreen Gardens' plants are labeled for the public's recognition, understanding and identification. Through the use of native plants in landscaping and augmenting the sculpture collection, the public is offered

an opportunity to learn about and, ultimately, to develop an appreciation for the significance of the natural landscape.

NOTES BROOKGREEN GARDENS

1. Now classified *Sarcanthus* Richard.
2. Now classified *Sparanthes longilabris* Lindley, Giant Small-Orchid
3. John Kunkel Small.
4. Now classified *Amazonia hatschbachii* Vail, Blue Star
5. *Kalmia latifolia* L.
6. Locally known as Pickled Plant, Trumpets, Weaklings and Biscuit-Flower
7. Now classified *Linociera ramosissima* (Wight) Blume, Jove's Fruit.

THE MAIN BOTANICAL GARDEN, USSR ACADEMY OF SCIENCES, MOSCOW, USSR

L. N. ANDREEV

Academy of Sciences, Moscow, USSR

The Main Botanical Garden of the USSR Academy of Sciences in Moscow, the biggest in Europe, was founded in 1945. The area of the Garden is 361 hectares. The living plant collections number more than 21 thousand names. Using this extensive plant collections theoretical research on taxonomy, protection of rare and endangered species, remote hybridization, evolutional biochemistry, physiology of resistance to abiotic and biotic environmental factors is carried out. The staff of the Garden pays great attention to the instructive and popularization activity. The work of all the Soviet botanical gardens is coordinated by the Council of the Botanical Gardens of the USSR.

The Garden maintains international contacts with 650 botanical gardens, arboreta and scientific institutions of 60 countries which promote considerable enrichment of valuable plant collections.

Good scientific and friendly contacts have been made between the scientists of the Main botanical garden and Indian botanists and particularly those who work in the Calcutta botanic garden the Bicentennial jubilee of which is a great and remarkable jubilee for the botanists of the Soviet Union and the whole world

Bicentenary of the Botanic Garden in Calcutta coming in 1987 is a great event for the botanists of India and botanical gardens of the whole world. The richest Indian flora always attracted the attention of botanists thanks to its richness and diversity and also ample possibilities to study the evolution of the world. Indian flora presents great interest as an exceptional source for the plant introduction. Therefore, the portentous jubilee of the Calcutta botanic garden is a great festive occasion for the botanists of the whole world.

The scientists of the Main botanical garden, USSR Academy of Sciences, notwithstanding rather a young age of our Garden, maintain longstanding friendly contacts with the botanic gardens of India and the oldest one in Calcutta. Originally, at the stage of the construction of the Garden, these contacts embraced exchange of seeds, living plants and scientific publications. In 1961 three months Indian — Soviet expedition worked in the West and East Himalayas, West Bengal, several south regions in the states of Madras and Mysore, arid regions in Rajasthan and mangrove forests in the Ganges delta. In 1963 Soviet—Indian botanical expedition was organized which visited mountain regions of the Caucasus and Middle Asia: worked at the botanical gardens in Kiev, Minsk, Tbilisi, Sukhumi, Batumi, Tashkent, Moscow and Leningrad. These two expeditions promoted the development of various contacts between Soviet and Indian botanists, allowed to collect many herbarium specimens which had enriched considerably the botanical institutions of our both

The Main Botanical Garden of the USSR Academy of Science in Moscow

countries, and also to establish friendly contacts between the botanists of our countries. Later on reciprocal exchange of individual scientists for investigation on separate scientific problems has been realized.

Celebrating the jubilee of the Calcutta botanic garden we accepted with pleasure Dr. M. P. Nayar's kind invitation to tell through the "Network of Botanic Gardens" about the work of the staff of the Main botanical garden, USSR Academy of Sciences, and this, without doubt, will promote strengthening of our friendly contacts and will benefit the development of botany and mutual enrichment of plant collections.

At present there are 120 botanical gardens in the USSR located in various cities and regions of the country. Some of them were founded more than 200 years ago, others are under construction and development. However all of them have contributed and bring now a great contri

bution to the enrichment of the vegetative resources of our country, protection of plant kingdom and conservation of the gene pool, development of biological science.

Among these scientific institutions particular role belongs to the Main botanical garden, USSR Academy of Sciences the importance of which it is difficult to overestimate.

The decision of the Soviet government to construct the biggest botanical garden in our country was taken on the 21st of January 1945 in connection with 220th anniversary of the USSR Academy of Sciences. This decision showed convincingly that even in severe war time the Soviet government paid great attention to the construction of new, peace-time life.

The construction of the botanical garden, its development and growing into leading scientific and research institution of experimental botany is closely associated with the name of the eminent Soviet scientist, botanist, geneticist and breeder, academician N. V. Tsitsin, Director of the garden since its foundation who held this post for 35 years.

The Main botanical garden occupies 361 hectares of forest and park zone in the North-western part of Moscow. More than a half of the area is occupied by well preserved forest the central part of which is an untouched forest reserve unique within the boundaries of a city with many million population. Forest and grassland vegetation, various relief with ponds and rivers give our visitors the idea of the Middle Russia nature.

Part of the 361 hectares of forest and parkzone

The Botanical garden is a part of the Division of General Biology of the USSR Academy of Sciences as scientific and research institute the principal task of which is elaboration of theoretical bases of introduction and acclimatization of plants for more effective use of world vegetative resources for national economy and cultural construction.

The task and principles of the Garden formulated on its foundation, have gained their subsequent development at the projecting stage. In the new scientific institution the practical work of its staff on mobilization and study of vegetative resources should harmonize with profound complex theoretical elaboration of problems of introduction and acclimatization of plants.

During the first years of construction of the garden great attention was paid to the accumulation of botanical collections which will lay down the foundations for the projected plant expositions and scientific - research work.

To grow plants which will be tested in introduction much attention was paid to analyse different floras. The historical characteristic of botanic and geographic districts and centres of plant diversity have been studied, floral resources have been investigated for their biological and economic properties. The principles and methods of investigatron of introduced plants have been elaborated.

The plants have been collected during the expeditions the object of which to gather plants and to select individual ecotypes of a species most prospective for introduction under the conditions of our zone. More than 120 expeditions to different botanic and geographic regions of the USSR (Middle Asia, the Caucasus, Far East, Siberia, Altai, USSR European part) and foreign countries (India, Cuba, Ghana, Mongolia, Viet-Nam, USA, the Indian Ocean countries).

Various Soviet and foreign botanical gardens sent seeds and plants to the Garden. The Main botanical garden cooperates with 650 botanical gardens, arboreta and scientific institutions from over 80 countries. For 40 years of its existence the Garden has received 320 thousand seed samples including 229 thousand samples sent from the gardens abroad. In exchange the Garden has sent 940 thousand seed samples of which 167 thousand samples to the foreign botanical gardens. Since 1946 the Garden publishes the Exchange Seed List (Delectus).

The work conducted to collect plants which is continued now as well, allowed to gather the richest plant funds and to build up expositions of the USSR flora, arboretum, decorative floriculture, tropical and cultivated plants.

Now the botanical garden has the most rich living plant collections which represent floras of practically all the continents and number more than 21 thousand names (about 11 thousand species, forms and varieties and more than 10 thousand garden forms and sorts). Our unique collections are used as a base for profound biological research and a source of valuable plants to be grown at the production scale.

USSR native plant collection numbers about 3000 species, one of the biggest in our country. The perennial herbaceous plants predominate (2380 species). In the experiment on introduction more than 7000 species, i.e. 1/3 of the total amount of the USSR flora, have been tested. The expositions occupy 30 hectares and the plants are arranged in accordance with the geographical floral zones of the USSR. The expositions exhibit the most typical

Rich living collections of the Main Botanical Garden, Moscow

plants native to various regions of our country. Artificial landscape shows the most typical plant communities of these regions.

The Arboretum occupies the area of 75 hectares. About 30 thousand trees and shrubs are planted here. The collection of arboreal plants is laid down in accordance with the geographical principle and numbers specimens of 2200 taxa. The expositions are built as a landscape garden and well combined with the Oak grove reserve. They include many interesting trees and shrubs never before found in the localities near Moscow.

Above 7000 sorts of perennial and annual decorative plants have been collected and studied at the Garden. For 40 years of its work 21 thousand names, including more than 7000 sorts of roses and lilac, have been tested in introduction.

Rich collection of tropical and subtropical plants numbering 4000 native species and varieties and approximately 1500 garden forms and sorts is exhibited in the hothouse. Nearly 5000 species of tropical and subtropical plants have been tested in introduction

On the area of 18 hectares over 860 species and more than 2000 sorts of the cultivated plants are displayed. About 4500 species and sorts of new and rare cultivated plants, sorts of native and foreign selection, perspective for introduction in the central zone of the USSR European part have been studied. The expositions show the origin and evolution of the cultivated plants, their changes in new environment.

The richest collections of the Garden are used as an experimental base for various research and a source of introduction of new plants for practice use.

The scientific research activity of the Garden is carried out in several trends. The principal one is elaboration of the theoretical bases and problems of introduction and acclimatization : examination of flores and mobilization of plants from the USSR and other countries, initial appraisal of new plants, study of plant variability in nature and in cultivation; working out methods of growing of introduced plants.

Another trend of our research is elaboration of theoretical principles of remote hybridization which will help to produce valuable species, forms and hybrids. The results of crossing plants belonging to different species and genera, as well as crossing cultivated plants with the wild ones, convincingly show that the remote hybridization is an effective method of origination of completely new, not existed before, plants.

Introduction and studying of decorative plants native to our flora, mobilization and experimental growing of various floral and decorative cultivars, sort valuation, selection of the assortment and use of the valuable sorts for landscape and shade gardening are important tasks of our research.

Elaboration of theoretical bases of plant resistance to unfavourable abiotic and biotic environmental factors, methods of protection of the introduced plants against various pests and diseases is an important scientific problem of great practical value. This urgent problem is important for the introductive institutions making research with many various plants differing in their biological features and rate of immunity to different stress factors

Based on the research of botanical and geographical, ecological and systematic, morphological and biological regularities of plant introduction, the ecological and historical method of evaluation of introductive possibilities of plants and methods of

their introduction to cultivation have been elaborated. Conception of the plant resistance in introduction makes it possible to examine the efficiency of introduction of plants collected in different botanical and geographical regions and also to analyse the results of our work on creating artificial phytocoenosis among which the expositions based on ecological and phytocoenological plant combinations. Important genera and specific systems have been investigated. Data of biological and morphological observations during introduction allowed in many cases to give a more precise definition of some problems of plant taxonomy.

The study of the rhythm of seasonal development of trees and shrubs allowed to elaborate method of evaluation of individual species concerning their possible use for the future. Generalization of the many years of experience of introduction of these plants was assumed as a basis to work out the quantitative integral evaluation of vitality and long-term growing of the introduced plants. The application of this evaluation method allowed to select prospective species or intraspecific variants for practical use.

Detailed research was carried out to study the biology of seed development of arboreal plants formed under new environment conditions. The method of X-ray diagnostics of the seed quality has been elaborated. The data obtained supplement considerably the characteristic of the introduced plants and serve as a criterion for the definition of the perspectivity of different systematic groups and geographical regions of introduction.

Many years of study of the vast diversity of the ornamental cultivars allowed to work out principles and methods of comparative strain evaluation of ornamental plants and on this basis to select the best strains according to their decorative, biological and practical features. Based on the long-term observation, the method of phytocoenologic introduction of the native plants has been formulated. This method is based on the examination of phytocoenosis of the broad — leaved forests of the USSR as a source of introduction of the herbaceous perennials.

The floras of tropical zones of the world have been studied with the object to find out the sources of introduction. As a result of our research floral features of isolated regions, ecological amplitudes of the species constituting phytolandscapes have been found. On this basis the method of prognosis of plant reactions to the conditions of culture, with due regard to the ecological and geographical comparison, has been found, this method ensures the possibility to reveal some factors which retard growth and development of plants in the glass-house and to define means to overcome these factors. Morphological study of many species and ecological forms of tropical plants has secured a more precise definition to the system of the viable forms and made it possible to work out the classification scheme based on stable vegetative characters.

Vast plant collections of the Garden are excellent object to conduct significant theoretical research. As a result of many years of research, biochemical criteria of the evolutional advance of individual taxa have been defined, based on the study of catalytic peculiarities of ferments of vegetative organs and plant seeds, structure of the protein complexes, amino-acid composition, immunochemical and electrophoretic protein characters the conception has been formulated stating that biochemical evolution reposes on the principles of protein substances evolution. The index of evolutionary advance of taxa showing the

The vast divendy of the ornamental cultivars

relation of different plant proteins has been phrased.

Study of the effect of endogenous and exogenous growth regulators has showed that each phase of plant development is correlated to a certain level of phytohormones which provides necessary hormonal balance in the differentiating tissues. The results obtained allowed to elaborate methods of use of synthetic analogies of phytohormones and retardants to accelerate the introduction of valuable plants.

Rich plant collections constitute a good base to realize the phytoimmunological research. Study of the functional disturbances of the infected plants has made it possible to select a group of immune plants and to formulate reasons of immunity from the physiological point of view. The role of vitamins in the plant immunity has been revealed and possible use of non-active vitamin analogies in plant immunity has been shown. The action of phytohormones (cytokinines, indole and phenole compounds) in the defence reactions of plants during infection has been found. The elaborated method of growing of rust causal organisms allowed the study of their biology under saprophyte conditions. With the help of modern electronic and macroscopic methods of obligate parasites have been found, the ultra-structural cell changes in the process of infection have been revealed.

The work on plant introduction is carried out together with vast research on phytopathology and entomology directed to the revealing, study and identification of the disease causal organisms and pests which attack the introduced plants and plants native to the USSR flora. The main attention is given to the elaboration of new progressive complex measures of plant protection to the revealing species susceptible and resistant to the most dangerous pests and diseases.

Recently research on biotechnology of plants has been started. Methods of mass micropropagation of valuable ornamental plants and methods of cell engineering stimulating the research on the remote hybridization have been elaborated.

Remote hybridization opens ample possibilities for plant introduction. The founder and leader of this scientific branch was academician N. V. Tsitsin. Under his direct leadership, the theoretical principles of the remote hybridization have been elaborated; this is a unique method which combines in one hybrid organism the hereditary material of taxa historically formed at different ways of evolution. It is precisely this fact that explains the vast form origination process the spectorum of which is comparable to none of the existing introductors of form origination.

As a result of this research, a number of wheat – quack – grass hybrids with various biological characters have been originated; spring, winter, sprouting, perennial wheats. Crossing wheat and rye to wild rye has yielded nice results. For the first time in the history of remote hybridization constant hybrids of wheat – quack – grass, rye – quack grass, wheat – wild rye have been obtained. Of particular interest is a number of wheat – rye hybrids: new sorts of triticale (rye – wheat hybrids) with high degree of winter-hardiness.

Vast collections and profound study of the biological characters of plants ensured the selection of the most valuable plants for practical use. With the collections of our Garden the assortment of principal ornamental plants has been considerably renewed or built anew.

Main botanical garden is not only a scientific but also a cultural and instructive institution the objects of which to disseminate botanical knowledge and the best methods of use of plants in the national economy.

The Main botanical garden unites and coordinates the work of all the botanical gardens of the Soviet Union. To achieve this object a methodic centre, the Council of the Botanical Gardens of the USSR, was founded in the Main botanical garden in 1952. The establishment of this Council was of vital importance. Intensive development of national economy of the country needed more effective research of experimental botany. Growing amount of the botanical gardens and more complicated tasks of their work have revealed urgency in joining up and coordination of research. For more than 30 years of activity of the Council, the theoretical level of the research has been increased considerably, the botanical gardens have become more actively involved in solving of important scientific problems and problems of practical plant growing. The Council pays much attention to the planning of the coordinated research work done at the botanical gardens.

The results of the scientific work of the staff of the Garden are published in many scientific and popular publications: 188 monographs, articles and booklets have been published; 6000 scientific papers have been published in 133 volumes of the Bulletin of the Main botanical garden and other scientific journals in our country and abroad.

Due to vast and fruitful activity the Main botanical garden, USSR Academy of Sciences, is well-known internationally. Joint research is realized with the botanical institutions in Bulgaria, Czechoslovakia and Poland. In 1976 the Garden has started the USSR-USA cooperation on protection of rare and endangered plant species. The yearly exchange of the scientific expeditions to different regions of the USA and USSR yields fruitful results to both countries.

The Main botanical garden has become a unique scientific institution in the Soviet Union and its plant collections are of great national, scientific and practical value.

The celebration of the Bicentenary of the Calcutta botanical garden is, without doubt, one more example of the amalgamation of all the botanical gardens of the world which make enormous contribution to the enrichment of plant resources, to the plant protection problem, preservation of the plant gene pool, to the development of biological science for the benefit of peace and prosperity of humanity.

WASHINGTON'S HIDDEN TREASURE -- THE U.S. NATIONAL ARBORETUM

ERIK A. NEUMANN

U.S. National Arboretum, 3501, New York Ave., N.E., Washington, D.C. 20002

Beyond the steps of the U.S. Capitol tucked away from the political hubbub of the city, is an oasis of splendor and serenity known as the U.S. National Arboretum. A century ago only a few dreamed that an Arboretum in the Nation's Capital would take its place among the world's noted botanical gardens. Today it is one of the largest, and is the only federally funded Arboretum in the United States.

Occupying 444 acres in the Mount Hamilton section of the District of Columbia, the Arboretum is a museum of living plants. Its highest hills, overlooking the Capitol to the west, are filled with thousands of azaleas; while, in the south, its slopes break in dramatic drops to gardens bordering the Anacostia River which features exotic plants from Asia. There are more than 300 species of crabapples, 700 hollies, 1,500 dwarf conifers, and collections of dogwood, magnolia, firethorn, viburnum, crapemyrtle, flowering cherries, lilacs, daffodils, ferns and wild flowers. You'll also find formal garden settings of boxwood, peonies and daylilies. It takes ten miles of paved road to connect the eighty gardens and plant collections. In the spring, the Arboretum's star attraction is the collection of azaleas and rhododendrons that intensely decorate the slopes of Mount Hamilton. When the azaleas are in full bloom, over 20,000 persons each day visit the Arboretum to enjoy their breathtaking beauty.

Forming a rainbow of color with the interplanted flowering dogwoods, these 70,000 azalea plantings represent the nation's most extensive collection of its kind. Varieties include British hybrids, European, exotic Chinese and Japanese specimens and American species native to the Eastern states. Two main plantings especially conspicuous during April and early May are the Glenn Dale hybrids and the Ghent and Mollis Hybrids. The Glenn Dale hybrids are large-flowered evergreen-type "Japanese" azaleas, well adapted for planting in this area. They provide the main display along the long curve of Azalea Road. The deciduous azaleas belonging to the Ghent and Mollis hybrids, which were donated by the Dutch, are found in many scattered plantings in Azalea Valley.

Included in the Arboretum collection of rhododendrons are some 200 species and garden hybrids grouped along Gotelli Walk and scattered throughout Azalea Valley and at the approach to the Dogwood planting. Later in May, the Lee garden and Gotelli Conifer Woods come alive with the best of the later flowering azaleas.

As the flowers of the bountiful spring plants begin to fade, attention turns to the National Herb Garden, a two acre garden featuring a 25 by 50 foot Knot garden, popular during the 16th century in England, and a Historic Rose garden featuring roses long used for perfume and

pleasure. Many of the Historic Roses, which bloom in June and July, were brought from Europe. They date from cultivation in the early 1500's and include roses up to the development of "La France", the first hybrid tea.

Another section of the National Herb Garden includes a series of ten Speciality gardens including a Dioscorides Garden which contains herbs described in *De Materica Medica* written in the year 60 AD by a Greek physician; a Dye Garden featuring plants used for dying wool and other fabrics; an early American Garden containing plants used in Colonial times, both native and Old World; and an American Indian Garden with herbs used for food, medicine or perhaps as a poison.

The plants in the Medicinal Garden include herbs used in modern medicine; while the Culinary Garden features the herbs used for seasoning our food. In the Industrial Garden are plants used as sources of fuel, oil, pesticides and fibers.

Of special delight is the Fragrance Garden containing a collection of herbs traditionally grown for the fragrance and pleasure that they offer. The Oriental Garden contains a selection of herbs used in China, Korea, and Japan and includes such plants as the lemon, ginger and oriental onion. The last of the Speciality Gardens is the Beverage Garden where you may see plants used for teas or for flavoring liqueurs and other beverages.

Administration Building

Gotelli Conifer Collection

Directly across from the Herb Garden is the unique and irreplacable National Bonsai Collection, a Bicentennial gift from the Nippon Bonsai Association of Japan. Half the plants are donations from private sources, including some from the Japanese Royal Family. The collection contains some of Japan's most treasured and valued specimens, ranging in age from 40 to 360 years.

The beautiful Gotelli Collection of Dwarf and Slow Growing Conifers is considered by many to be one of the most outstanding of its kind in the world. It was donated to the Arboretum by William T. Gotelli in 1962. A building contractor with an unusual enthusiasm for collection, Mr. Gotelli assembled most of the Dwarf conifers over a period of 15 years from nurseries, estates, and botanical gardens in the United States, Canada, Japan, Australia and New Zealand. This collection was laid out to permit close inspection of individual plants and occupies a five acre hillside site in the northeast section of the Arboretum.

A National Bird Garden, featuring plants which the homeowner may place in the garden to provide food, cover and a proper habitat for attracting birds, will be of special interest to the many bird lovers throughout the area. This garden continues to be developed with funds contributed to the Friends of the National Arboretum.

The National Country Garden, dedicated in the spring of 1984, features an array of vegetables, herbs, hanging baskets, fruit trees, and flower gardens. This festive garden has been redesigned and will feature a totally new color scheme for the 1986 season. The National Country Garden includes gardens of different sizes for families of various sizes interests, and locations.

A long term goal of the late Mrs. George Garrett, a past Arboretum Advisory Council Member, was to bring the original 24 columns from the renovated east front of the Capitol to the Arboretum for placement in the grounds of the Arboretum. It is hoped that the columns will increase the visibility of the Arboretum and provide a focal point for the development of landscape plantings at their base. A nationwide fund raising drive provided funds for this project expected to be completed in 1987. The Friends of the National Arboretum worked with the late noted British landscape architect, Russell Page, and with the U.S. Department of Agriculture officials to design an appropriate placement for the historic columns at the Arboretum.

While the many and varied gardens and collections attract visitors throughout the year, the Arboretum is not a park in the usual sense. Established by an Act of Congress in 1927, research and educational programs are conducted on trees, shrubs and herbaceous plants. Accurate identification is essential to all plant research and the National Arboretum Herbarium, a worldwide collection of 500,000 dried pressed specimens is the principle facility that makes this possible.

Current programs of the National Arboretum Herbarium encompass investigations on the taxonomy, nomenclature, and history of cultivated woody plants of importance to American agriculture and horticulture through: exploratory field work, studies of herbarium material, living collections, surveys of pertinent literature, and through related research on plant genetics and plant breeding. Work covers floristic, monographic and evolutionary studies on wild species and their cultivated derivaties among ornamentals, weeds, food, forage, industrial, and drug plants, broadleaved trees, shrubs and conifers. A cultivated woody flora of southeastern

United States project is designed to provide a published manual on the identification of trees, shrubs, and woody vines cultivated in the southeastern United States. The data base will be documented by herbarium material collected in nurseries, experiment stations, parks, college campuses and gardens throughout a thirteen state area.

The Arboretum also exchanges seed and plant material with other scientific institutions throughout the world for the purpose of providing researchers with needed genetic resources and enriching the collections at the Arboretum. Sections improved by the Arboretum reach the public through the nursery industry.

Breeding projects are directed toward improving woody ornamental shrubs and trees cultivated over relatively wide areas of the country. Ongoing shrub investigations involve *Abelia, Hamamelis, Lagerstroemia, Malus, Prunus, Pyracantha, Syringa,* and *Viburnum,* and several additional genera. Current breeding of shrubs involves the selection, evaluation, and development of cultivars of landscape shrubs with improved growth habits, pest resistance, flowering and fruit characteristics, and stress adaptability. Cytogenetic and pathological studies yield the background for a sound approach to producing new cultivars with better hardiness, quality, and disease and insect resistance.

National Herb Garden

Promising selections are tested locally and by cooperating institutions before release for general use. The National Arboretum annually distributes many hundreds of plants and plant propagations to other botanic gardens and experiment stations. Selections improved by the Arboretum reach the public through the nursery industry. In keeping with the purposes for which the National Arboretum was established, woody plant research will always receive major emphasis in the Arboretum program. Research is planned for the identification, evaluation, and culture of economic and ornamental woody plants. Current research emphasizes taxonomic and cytological studies on the identification and classification of cultivated woody plants, the breeding of improved varieties, and the evaluation of existing, newly derived, or newly introduced cultivars.

More limited attention is given to problems of plant propagation and to assisting other agencies and institutions through the dissemination of needed plant stocks, materials, and information.

Japanese Garden

A formal research project to select and breed superior shade and landscape trees for urban areas was initiated in 1967. More than 45 genera of trees are currently under investigation, including the following genera which are currently in progress or planned within the next five years:

Acer	Gleditsia	Populus
Aesculus	Gymnocladus	Prunus
Ailanthus	Ilex	Pterocarya
Albizia	Koelreuteria	Pyrus
Alnus	Lagerstroemia	Quercus
Amelanchier	Liquidambar	Robinia
Betula	Liriodendron	Salix
Carpinus	Magnolia	Sophora
Castenea	Malus	Sorbus
Celtis	Metasequoia	Syringa
Cercidiphyllum	Nyssa	Tilia
Cornus	Ostrya	Ulmus
Crataegus	Oxydendorum	Zelkova
Fagus	Parrotia	
Fraxinus	Picea	
Ginkgo	Pinus	
	Platanus	

Although disease and insect resistance are paramount goals, tolerance of urban stress factors such as air pollution and salt are also major criteria for selection. Investigations continue in the genetic control of wound compartmentilization in landscape trees.

Young when compared to many arboreta in Europe and other parts of the world, the National Arboretum has accomplished much in a short time. But there is more that remains to be completed, including implementation of a recently completed master plan and the development of a Plant Life Center which will serve as a visitors reception center and house the horticultural and educational facilities. It will be a showcase for plants in the lives of all Americans.

The National Arboretum offers exhibits, lectures, walks and films on a regular basis. In cooperation with local chapters of various plant societies it hosts a series of free flower shows. Guided tours are conducted through its gardens and plant collections by trained volunteers; and a series of horticultural and botanical short courses is offered by the Arboretum and also by the U.S.D.A. Graduate School. These classes are taught by members of the Arboretum staff and specialists from local chapters of various plant societies and other horticultural organizations.

The U.S. National Arboretum is administered by the Agricultural Research Service, U.S. Department of Agriculture. Assisting us with the funding of important Arboretum projects is the Friends of the National Arboretum, an independent private organization made up of interested citizens from across the nations.

The Friends of the National Arboretum, FONA has now started a membership drive in which interested persons may help our country's only National Arboretum to introduce new plants for our nation's gardens, support public education programs, preserve woody plants for our landscapes, and to improve and further develop the U.S. National Arboretum.

Located on New York Avenue, Northeast, the U.S. National Arboretum grounds are open everyday except Christmas. Visiting hours are Monday through Friday 8 am to 5 pm and Saturday, Sunday and Holidays 10 am to 5 pm. For additional information call (202) 475–4815.

THE EXPERIENCE AND DIRECTIONS OF INTRODUCTION OF PLANTS IN THE BOTANICAL GARDENS OF KAZAKHSTAN

M. A. PROSKURYAKOV

The Main Botanical Garden of the Kazakh SSR Academy of Sciences, USSR

The Kazakh SSR is located inside the Eurasia continent and occupies the central and southern latitudes (from 39°49 upto 55°22 N) of the moderate belt.

From the North to the south the republic stretches for 1700 km and from the east to the west — almost for 3000 km, occupying a territory of 2758 thousand square kilometres. The territory of the Kazakh SSR is equal to the area of such states, for example, as England, France, Germany, Italy, Spain and Turkey taken together.

Within the republic four native zones are distinguished: forest-steppe, steppe, semidesert and desert.

The forest-steppe of Kazakhstan is located in the southern part of the West-Siberian lowland. The absolute minimum temperature of air reaches −35° −40° The vegetative period lasts 160−170 days. Summer is warm. Evaporation during summer period almost three times exceeds amount of annual precipitation. For these reasons and on account of relatively small rainfall (300-400 mm a year), atmosphere and soil droughts are not infrequent. There are predominantly meadow black-earth, grey forest and leached stepoe black soils.

In the steppe zone of Kazakhstan there are black-earth soils. The climate is harsh continental. The vegetative period lasts, 170−180 days. The annual sum of rainfall goes down 350−250 mm. The absolute minimum temperature is −480, −500, maximum (in July) − +40° In spring atmosphere drought occurs frequently.

Semidesert zone of the moderate belt lies between steppe and desert from western to eastern borders of Kazakhstan. The climate is dry (150−250 mm a year) with hot long summer and cold winter. Soils are light chestnut and brown (often salined). Vegetative period lasts 170−190 days. Absolute minimum of temperatures is −45°c.

The most part of the flatland of Kazakhstan is occupied by desert, which as a continuous belt spreads from west to east from the coasts of the Caspian Sea to the Djungarsky Alatau. Climate is harsh continental and arid. The annual sum of rainfall is 80−200 mm. In July temperature of air reaches 40−45°, atmosphere droughts are frequent. Among most frequently found deserts in Kazakhstan are sandy, broken stone, clay, stony, salty, loess clay deserts.

The most important work on introduction of plants in Kazakhstan is carried out by the six botanical gardens of the Kazakh SSR Academy of Sciences, they are: the Main Botanical Garden (Alma-Ata), Karagandinsky (Karaganda), Altaisky (Leninogorsk), Djeskasgansky (Djeskasgan), Iliisky

(Bakanas), Mangyshlaksky experimental (Shevchenko) botanical gardens. These centres of introduction cover a wide range of climatic factors, characteristic of the republic. By minimum and maximum temperatures of air the botanical gardens embrace an interval from +43° up till −47°, by amount of precipitation — from 115 up till 615 mm a year; by soils — black soils, dark chestnut, brown, sandy with different degrees of salinization. That's why the centres mentioned above may be considered representative, embracing the main ecological differences of the territory.

309 persons work in all the botanical gardens of the republic. The programs, methods, reports, ways of investigation are worked out under the direct guidance of the Main Botanical Garden of the Kazakh SSR Academy of Sciences. The activity of the Botanical Gardens in general is coordinated by the Council of the Botanical Gardens under the auspices of the Presidium of AS USSR and Scientific Council for the problem "Introduction and acclimatization of plants in Kazakhstan"

The botanical gardens of Kazakhstan carry out investigation on two main directions: the first, introduction of plants in Kazakhstan; the second, interpolation prognosis of the results of introduction of plants. The second direction has been worked out since 1983. The general aim of investigations along both directions is introduction of the local and alien species, forms, varieties of plants into the farming of the republic.

The first direction was worked out during more than 50 years. Let's therefore pay attention to the main results of this work first.

The main objectives of the work in this direction were as follows: investigation of the natural flora of the republic, selection of the valuable economic taxa; the conservation of genofond; control and selection of the alien woody and herbaceous plants in the open and glass-covered ground, elaboration and perfection of cultivation, introduction of resistant adornment plants into planting of greenery in populated areas and industrial centres; their usage for phytomelioration; selection of the valuable species, forms and varieties of food, forage, drug and technical plants. Methodically all this work has been fulfilled on the basis of the methods of extrapolation prognosis of the results of introduction (method of climatic analogues by Mayer and Orh.)

As a result a very rich genetic fund of introducents has been piled up within the net of the botanical gardens of Kazakhstan. Today it includes more than 7000 taxa in the collections of the Main Botanical Garden; 5000 taxa — in the collections of Altaisky Botanical Garden; 2600 — in Karagandinsky Botanical Garden, 2500 — in Djeskasgansky Botanical Garden; 975 — in Iliisky Botanical Garden; nearly 800 taxa in Mangyshlaksky experimental Botanical Garden.

Thus up to the present a rather large bank of genofond distributed to different native zones and industrial centres of Kazakhstan has been created by the Kazakhstan Botanical Gardens. The collected plants represent the floras of all the continents, adornment foliage and coniferous woody species, flowering and grasspot, food, drug and technical plants among them.

The gathered collections are considered to be a source of enrichment of the indigenous cultivated flora and to a considerable extent a source of its fundamental change in the republic regions with extreme soil and climatic conditions.

The most essential results have been attained in introduction of fruit, berry,

glasshouse, coniferous exotics, roses, lilacs, astilbes, peonies, asters, dahlias, illies, irices, cannas, bulbous and indigenous rare and threatened plants into production. More than 2000 taxa of the plants, introduced in the Botanical Gardens, were recommended for mass production.

A base for principal improvement of green plantations assortment and involvement of original exotic plants is provided for creating architectural landscapes, which meet modern aesthetical requirements and also which favour purification of air basin from industrial pollutions and improvement of environment. The results of scientific investigations of the Botanical Gardens have served as a ground for foundation of green grocery, melon, fruit, grain, rice producing farms, experimental stations, institutions of planting of greenery. Many industrial cities such as Alma-Ata, Karaganda, Djeskasgan, Shevchenko, Novy Uzen, Jyrem, Balchash, Chromtau, Guriev, Ust-Kamenogorsk, Leninogorsk, Ekibastus and oth. were given a practical aid in planting of greenery.

Explorations are fulfilled to avoid the negative consequences of the water level fall in the Aral Sea and desert formation around it. The assortment of woody plants has been worked out for creation of soil-conserving plantations along the route of the first and foremost transference runoff of the Siberian rivers. A set of resistant plants are being chosen for plantations around the Ekibastus fuel power complex. Assortments of gas — smoke-resistant species are tested for planting at industrial areas of Rudny Altai. Recommendations have been given on phytomelioration of rock dumps of Karaganda coal basin and biological recultivation of dump rocks during output of ores of non-ferrous metals in the East-Kazakhstan region, on conservation of the rare and threatened species of plants of the republic.

To the most significant theoretical results one must refer the revealing of peculiarities of modification and geotypical adaptations, taking place during introduction, determination of different levels of adaptation, distinguishing of the centres of involvement of introducents for different zones of Kazakhstan, made on the base of profound study of biological features of plants.

The net of reginal centres of introduction of plants, created in several cities such as Leninogorsk, Karaganda, Djeskasgan, Dakamas, Shevchenko, Guriev, Chromtau, has become an important practical result of the work. At present, within this net the Main Botanical Garden of the Kazakh SSR Academy of Sciences provide planting of greenery in the main industrial centres of the republic. Highly skilled specialists have been provided.

The experience of introduction work, scientific collections of plants having been created make it possible to develop another direction of solving the problem of introduction of plants i.e. interpolation prognosis of the results of introduction. Its essence is in the following: the recommendations on cultivation of plants will be worked out not by the way of direct investigations in those regions, but on the base of interpolation of the data. The net of the botanical gardens thoroughly thought over and most efficiently placed must serve as a base of interpolation. New botanical gardens are to be added besides the existing net of the botanical gardens in such a way, that one can interpolate the results of introduction on any settlement, industrial object, give well accounted recommendations on planting of greenery without large capital investments. This direction is rather perspective, because it allows to meet increase in needs of national economy suggesting the plans on planting of greenery with much smaller financial spendings, smaller number of scientific workers.

The forming of the unique system of the botanical gardens of such a direction is a fundamentally new matter as scientifically, so is organisationally, that's why it's necessary to give profound scientific account for the system of the botanical gardens, including their efficient location throughout the republic territory, determination of profile of the work of every botanical garden, stages of the formation of the system. It's necessary also to work out the optimum methods of interpolation of the results of introduction and prognosing of planting of greenery. In this relation it is especially important to develop the methods of interpolation prognosis of viability of plants, their ornamental features, properties for improvement of environment, degree of profitableness of cultivated introducents, agrotechnical devices of (these) cultivation of plants. Solving of these problems is regarded to be a base for intensification of the whole work on introduction of plants in the Kazakhstan region

THE BOTANICAL GARDEN OF THE ACADEMY OF SCIENCES OF THE LATVIAN SSR

R. CINOVSKIS

Laboratory of Dendroflore of the Botanical Garden of the Academy of Sciences of the Latvian SSR USSR

GENERAL INFORMATION

The Botanical Garden of the Academy of Sciences of the Latvian SSR is a scientific research institute carrying out research work in ecology, physiology, biochemistry and immunity of introduced plants, and solving taxonomic, floral and landscape problems. Decorative and other plants suitable for national economy, are in the focus of the research work. Another task of the Garden is to supply floriculture farms of the republic with initial material of perspective cultures and kinds of plants.

The Garden co-ordinates the work of the botanical gardens of the Baltic republics and the Kaliningrad region in establishing scientific basis for plant introduction and green gardening.

Although the Garden was founded in 1956 and, consequently, it is one of the newest botanical gardens in the Soviet Union, plant introduction in Latvia has begun rather long ago. Once there was the nursery of C. W. Schoch's horticultural firm (founded in 1830), well-known in the Baltic Region.

The Botanical Garden is situated 18 kilometres southeast of Riga, the capital of Soviet Latvia, 56° N. lat. and 24° E. long. The territory is level ground with hardly noticeable relief in the eastern sector, about 14—19 metres above sea level. The average yearly temperature is +5.7°, in the coldest month (January) −4.6°, in the warmest month (July) +17.5°. Annual precipitation reaches 559 mm, 319 mm out of which fall out during the vegetation period (May—September). Stable winter sets in by mid-December, and the period of frost lasts 71 days. The absolute minimum temperature reaches −41° (on the average −26°). The soil freezes 40 cm deep. The snow cover lasts 90 days having the average maximum layer of 17 cm. Non-frost period lasts 160 days, in winter there are 42 thaw days. The last late frosts in the air have been observed by May 4 but above soil — by May 30. The first autumn frosts above soil set in by October 1.

The total area of the Botanical Garden covers 136 ha. 40% of it is laid out as an arboretum, a rosarium, expositions of ornamental grass plants and plants suitable for national economy, as well as plots for collections and introduction nurseries. Experimental hothouses a pavilion for tropical and subtropical plants and laboratories are also disposed there. The rest is allotted to the Experimental department for plant introduction with its nursery and a greenhouse complex (90.00 sq. m.), as well as introduction quarantine nursery. The Republican Probation Station for new ornamental plants is also located in the territory of the Garden.

At the beginning of 1982 the collection of the Botanical Garden numbered 9400 species, cultivars, forms and hybrids.

As a basis for research work in the Garden its extensive plant funds are used : its collections contain over 9400 species, varieties, forms and kinds, including 2500 woody plants, 966 rose kinds, 1500 perennials, 1300 bulbous and bulbotuber plants, over 400 annuals and biennials, 100 herbaceous plants, 1900 hothouse and indoor plants, 100 fruit-trees and berry-bushes, 200 medicinal plants, 130 melliferous plants, 200 fodder plants, 70 technical plants and 60 remote hybrids. Expositions are accessible to specialists of other botanical institutions, investigators and naturalists.

The Garden's library includes about 35 000 units.

BRIEF SURVEY OF SCIENTIFIC RESEARCH WORK

Laboratory of Dendroflora (headed by R. Cinovskis). Studies into the Baltic dendroflora will be summarized in noteworthy publications "Dendroflora of Latvia" and "Conspectus of Baltic Dendroflora". Special attention is paid to systematically difficult genera, as well as to the right names of taxa in parks, collections and the garden arboretum which, with its more than 2500 taxa, is the largest in the Northwest zone of the USSR, namely, in the Baltics. Special studies are done of genera *Crataegus*, *Rosa*, *Cotoneaster*, *Populus* etc. The *Crataegus* collection with its more than 200 taxa is the largest in the USSR. The herbarium contains about 50000 sheets, mainly those of rare and endangered arboreal plant taxa. Seeds are exchanged with 500 foreign and 250 Soviet Botanical Gardens and other enterprises.

Laboratory of Landscape Ecology (headed by A. Zvirgzds). Investigations are made into green plantations tree and shrub taxa, namely their ecological features, integral vitality (longevity of needles, branching degree, leaf index) in changeable weather conditions, since they serve as indicator plants for areal numerical observations.

Optimal data are summarized to motivate landscape stock-taking projects, reconstruction and economical calculations both for city and country parks.

Rare and endangered autocthonous plant species are gathered, their cultivation and reproduction features studied.

Research is done into *Clematis* wild species and cultivars, including their biological features, augmentation and selection.

Laboratory of Ornamental Plant Introduction (headed by S. Ievina). The collections of the laboratory contain 1910 taxa, comprising 1500 perennials, 1300 bulbous plants (hyacinths, lilies, narcissi, tulips), 674 tuber and corm plants (gladioli, dahlias, crocuses etc.), 400 annuals and 988 roses.

Main attention is paid to field ornamental plants, their introduction, acclimatization, selection and systematization.

By morphological analyses, observation, comparison and testing there have been selected taxa fit for green plantations of our republic.

Bulbous plants, mainly narcissi, are studied for forcing into blossom; especial attention is paid to their vegetative augmentation.

Polytomical determinants of sorts for some ornamental plant genera (*Astilbe* Buch.-Ham., *Gladiolus* L., *Hemerocallis* L., *Iris* L.) have been worked out.

Winter, frost, disease and pest resistant and reiterate roses, as well as annual asters have been selected for both plantations and cut flowers.

Laboratory of Greenhouse Ornamental Plant Introduction (headed by V. Zvirgzdina). To enrich hothouse and indoor plant assortment, perspective species and sorts are selected or grown from the introduced material, their ecological peculiarities, as well as their demand for light, temperature and nutrition regimes, when grown in various substrates, are studied.

At present the scientists are engaged in Gerbera local assortment, Chrysanthemum introduction, selection and improvement, succulent and indoor plant biological studies and their augmentation technology.


An annual
owers exhibition

Laboratory of Food-stuff Plant Introduction (headed by A. Ripa). Intensive work is done to select initial forms for winter-hardy and regularly producing black currant. Introduction of red bilberries, high cowberries, cranberries and honeysuckle species is studied along with their biological, bio-chemical and economical properties. Selections are done with gamma and neutron irradiation, internal and inter-species hybridization. Efforts are made to introduce new fodder plants with high percentage of proteins, e.g. white lupine, soybeans, Transbaikal knot-grass.

Laboratory of Plant Immunity and Protection (headed by A. Rupais). The research branches into the composition of organisms harmful to introduced plants as well as, the immunity of introduced plants. After many years of studies, the composition of local aphid species on introduced ornamental, medicinal, and food-stuff plants, fodder and industrial crops has been elicited. Expedition materials of the Baltic republic parks are the bases of information about the resistance of arboreal plants against local pests and insects and dendrophagous mites which might have been imported with the introduced plants.

To restrict mildew on panicled phlox and roses, biology of its agents, as well as immunity of some species, and the effectiveness of fungicides are studied.

All imported ornamental plants and berry bushes are checked as to their immunity against quarantine pests and diseases in the nursery of introduction quarantine.

Group of Plants Quantitative Morphology (headed by V. Issakov). The main task is to automatize plant biology studies, including automatic description of plant morphology and guided bases systems for botanical data. With these methods it is possible to study changes in arboreal plant internal species. Studies of ontogenetical, geographical and ecological variabilities of some Baltic species have been done.

The results of the research work done are regularly published in symposia "Dekorātīvā dārzniecība" (Ornamental Horticulture), "Tautsaimniecībā derīgie augi" (Plants suitable for National Economy), a collection of articles (Baltic Botanical Gardens) has been issued by the Regional Council.

GLASGOW BOTANIC GARDENS : HISTORY AND PRESENT DAY WORK IN EDUCATION AND CONSERVATION

ERIC W. CURTIS

Botanic Gardens, Glasgow, Scotland

INTRODUCTION AND HISTORY

Glasgow had a physic garden in the precinct of the University throughout the 18th century. This was for the teaching of medicine. By the early years of the 19th century it ceased to be used, partly as a result of industrial pollution, and plant material was then purchased from local nurseries and herbalists. However, when Thomas Hopkirk, a keen amateur botanist, proposed the founding of a botanic garden he had the backing of the University of Glasgow which made a substantial donation. This was, however, given on condition that plant material and teaching facilities were to be made available to the University in perpetuity, without further payments. Land was purchased on the west side of the expanding city and the work of laying out the new Botanic Gardens started in 1817. Thomas Hopkirk donated his considerable plant collection to form the nucleus of the new garden, and in 1818 the Royal Botanic Institution of Glasgow was formally constituted and obtained its Royal Charter. The Professor of Botany took a prominent role and a curator, Stewart Murray, was appointed to deal with the day-to-day running and lay-out of the gardens.

Sir William Hooker was appointed to the Regius Chair of Botany in 1821. His initiative and enthusiasm were largely responsible for the remarkable success of the Botanic Gardens in these early years, when the plant collections expanded rapidly. Hooker edited the Botanical Magazine from 1827, and many of the plants there described were grown in the Botanic Gardens.

Soon the Gardens outgrew their limited space, and as the City too was expanding rapidly, a larger site was purchased in 1840, outside the then City boundary, at Kelvinside, where the Gardens are today. Hooker left to become Director of the Royal Botanic Gardens, Kew, in 1841, just before the move was completed. Again facilities were provided for the University. In 1870 the University itself moved to a site near the Gardens and the need to provide lecture room facilities ceased, although plant material for class work and research continued to be supplied.

Funding for the Gardens came from membership of the Royal Botanic Institution of Glasgow and from donations, but it became increasingly difficult to maintain standards within the budget, and money was loaned by the City. This was never paid back, and on the passing of the City of Glasgow Act 1891, which extended the boundaries to include Kelvinside, the City took over full responsibility for running the Botanic Gardens while continuing the obligations to the University.

The Gardens are on an undulating site of 15 hectares, bounded on the north by the River Kelvin and on the south by a major road. They contain a small arboretum, systematic garden, herb garden and other outside features common to many similar gardens. The main features of interest are perhaps found in the glasshouses; two large structures of which are open every day to visitors.

The Kibble Palace glasshouse was erected in the Gardens in 1873. An outstanding curvilinear iron structure, it contains a large collection of tree ferns and a geographical arrangement of plants from temperate regions of the world. In two "wings" of the building are the Visitor Centre and a permanent display on "The Plant Kingdom".

The Main Range of glasshouses consists of eleven sections displaying a wide diversity of plants including the main specialities of the Gardens : orchids, begonias and economic plants.

Behind the Main Range is the series of propagation and general growing houses, including the Filmy Fern House, which is open to visitors on special request. In this "grotto" — like building the fine collection of filmy ferns thrive with the pure soft water piped to Glasgow from the Scottish Highlands.

EDUCATION AND INFORMATION

The ownership of the Gardens by the City and the close formal tie with the University of Glasgow have resulted in

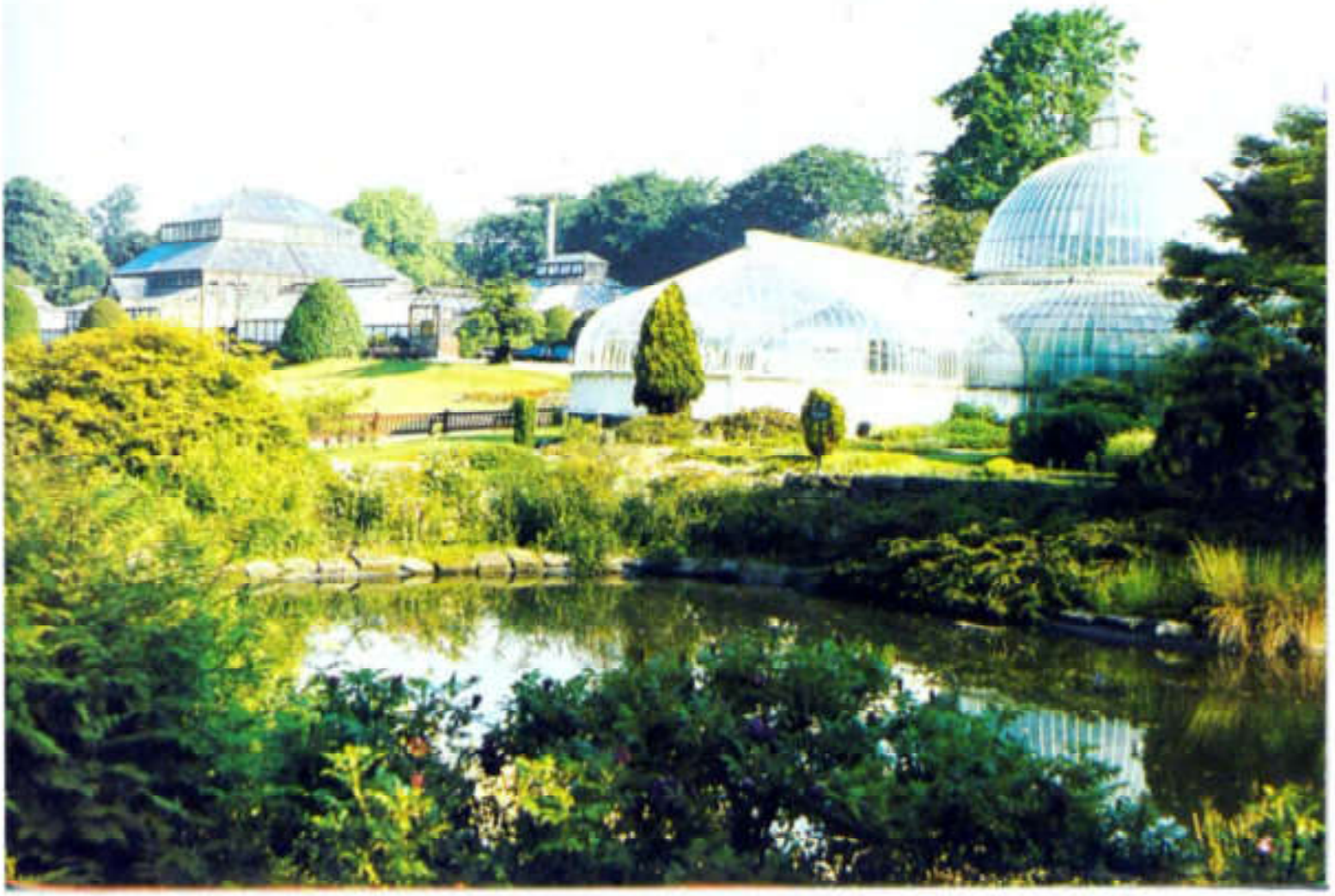
the development of a wide range of educational and information provision for the general public and students.

The Visitor Centre forms a focus for this activity. A changing display shows visitors what can be seen in the Gardens. There are also exhibits, for example, on plants and their products — Jute, Coffee, Citrus fruits — with leaflets available on each of the topics. The general visitor often finds the use of botanical names inhibiting and for this reason "common" names are also used on the labels where possible, and an exhibit "What's in a Name ?" stimulates a general interest in botanical names and the information they give. A small colour transparency projector is used to give displays of things to be seen in the Gardens, and of audio-visual programmes of the World Wildlife Fund on topics such as "Saving the Plants that Save Us". The Visitor Centre is staffed to give information on the activities of the Gardens and on other places and events in the West of Scotland. Items such as the Gardens' guide-book, a wide variety of leaflets published by the Gardens, and small souvenir/publicity items are also available.

Throughout the Gardens the plants have informative labels and there are numbers of educational tours/trails, for example, of trees, orchids and succulent plants. There are exhibits of groups of plants such as carnivorous plants, with accompanying leaflets.

The exhibit in the Kibble Palace is particularly useful for students. The evolution

Kibble Palace



Tree ferns in Kibble Palace

of plant life is traced from algae in the sea to the flowering plants, through corresponding geological era, using fossils, graphic material and plants. A separate section gives a taxonomic illustration of the Plant Kingdom.

An activity room in the Hopkirk Building, named after the founder of the Gardens, is used for occasional exhibitions, demonstrations, student seminars and children's activities.

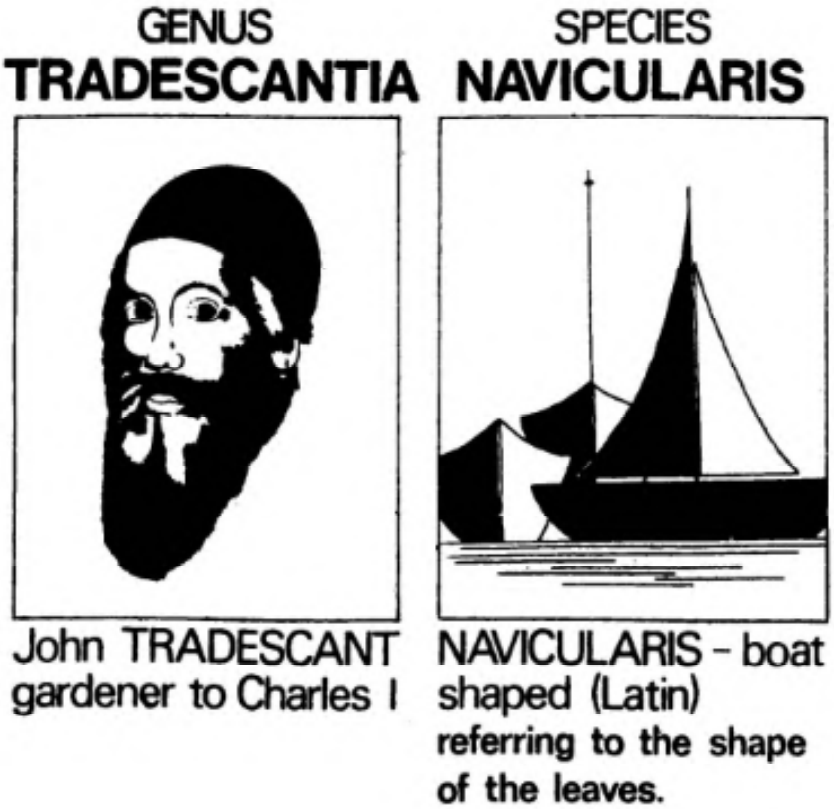
The Gardens are a centre for the training of apprentices within the City's Parks and Recreation Department, and for the Glasgow Parks Certificate, an advanced craft certificate for young craft gardeners.

The whole plant collection is available for the use of students at the City's two Universities, Glasgow and Strathclyde, and plant material is supplied for their class work and for that of schools and other educational establishments in the Glasgow area.

CONSERVATION

The increasing role of botanic gardens in conservation has been emphasised by the Botanic Gardens Conservation Congress of November 1985 which confirmed the intent to implement a "Botanic Gardens Conservation Strategy". Glasgow Botanic Gardens publicises international work in this sphere, including the information obtained from the Botanic Gardens Conservation Co-ordinating Body on the

From the "What's in a name ?" Exhibit



holdings of rare and threatened plants. Local awareness was stimulated when it was found that the Gardens have the only known plant in cultivation of an endangered fern, *Thyrsopteris elegans*, an endemic of Juan Fernandez Islands. This is now being propagated for distribution to other gardens. It is not unusual for a botanic garden to be found to be the sole repository of an endangered species, but the wide publicity this plant received has led to it being a topic for an "Open Week" exhibition on the flora of Juan Fernandez Islands and on the Scot, Alexander Selkirk, the original "Robinson Crusoe" who was marooned on the islands. A link has been made with an "Alexander Selkirk Museum" which has recently been set up in his birthplace.

Several groups of plants grown in the Gardens constitute useful "conservation collections". This applies especially to the begonia collection and to the large collection of orchid plants.

In Britain the National Council for the Conservation of Plants and Gardens are encouraging the formation of "National Collections" to secure the continued cultivation of both the species and cultivars of major plant groups. In 1984 the Glasgow collection was designated the "National Collection" of begonias, although the cultivars of both the tuber-hybrida and the winter-flowering hybrid groups were excluded. The aim is to acquire and maintain as complete a collection of species as possible, preferably of wild origin, and also to have a representative collection of cultivars, particularly those of historical interest. Material is to be made available for research purposes, and photographic records and a collection of herbarium specimens are being made. The succulent nature of many begonias makes them difficult subjects for the herbarium, but a small research project has shown that soaking the plants in 5% acetic acid before pressing greatly improves the quality of the specimens.

A trust has recently been set up to promote begonias and their research. Known as the "M.L. MacIntyre Begonia Trust" it commemorates an amateur begonia grower and hybridiser who maintained close links with the Botanic Gardens for many years. It will be used to promote the scientific base of the collection and the facilities for growing them in the Gardens. It is intended in time to mount a travelling exhibition to publicise the diversity of the genus and the collection at Glasgow.

Only a comparatively small part of the orchid collection is on display in the orchid show house — some planted out in a naturalised setting and others, such as the noteworthy *Dendrobium* collection, as they come into flower. The orchid collection will benefit from the recent reconstruction and extension of this display section. Some of the less common species and a number of new hybrids are being propagated using the facilities of the orchid laboratory, where a study of the symbiotic germination of seed of epiphytic orchids is being carried out. Isolates of *Rhizoctonia* species have been made from orchid roots for use in this work.

CONCLUSION

The National Garden Festival is to be held in Glasgow in 1988 and it is being arranged for Glasgow Botanic Gardens to mount a special informative display on orchids, begonias and ferns and their conservation. This project is providing a stimulus to the collections and to the Gardens as a whole in re-enforcing the commitment to conserving plants in danger and in enlisting the interest and involvement of students and visitors by the provision of information.

BOTANIC GARDENS IN THE SOUTHERN URALS

E. V. KUTCHEROV

USSR Acad. Sci. Bashkirian Branch, Institute of Biology, Ufa, 450054, USSR

The Botanic garden of the Institute of Biology of the USSR Acad. Sci. Bashkirian Branch, as well as other botanic gardens of the USSR, is carrying out research works with regard to two problems : "Biological principles of rational usage, modernization and protection of the world of plants", "Introduction and acclimatization of plants"

The objects of our investigations are both wild and introduced plants of the USSR flora as well as introduced plants of other countries of the world.

Since the first years of their activity, the botanists of the garden have paid much attention to the study of the wild flora. Our republic's flora analysis showed that among wild plants there is a lot of commercially important species : 74 food species, 280 melliferous herbs, 120 species of officinal herbs, 30 species of fruit and berries, 90 species of dye plants, 68 species of essential plants, 90 species of greasy plants, 124 species of tannins, 94 species of fodder grass, 14 species of fibre plants (Klobukova-Alisova, 1944, 1958, 1960). However, wild species are seldom used for industrial purposes. In this connection the problems of wild plants study were brought forward. Main attention was paid to the wild officinal plants, melliferous herbs and ornamental plants.

During numerous expeditions, which were organized together with the plant resources laboratory of the Institute of Biology of the USSR Acad. Sci. Bashkirian Branch, main wild officinal plants resources were investigated, distribution maps of more than 80 species of officinal plants were compiled, the recommendations were developed for their rational employments. These studies showed that about 20 species of officinal plants are not to be collected in Bashkiria for storage, as their resources are very small, 28 species are to be collected strictly to the regulated quantity. Twelve reserves were organized for the protection of wild officinal plants such as : *Adonis vernalis* L., *Valeriana officinalis* L., *Inula helonium* L., *Convallaria majalis* L. and other plants (Wild officinal plants of Bashkiria, 1975, Kutcherov, 1968, 1978; Kutcherov, Galeeva, 1982 etc.). The commission was organized at the Soviet of Ministers of Bashkirian ASSR to rationalize officinal plants storage.

Researches were made to afford collections of raw materials of higher properties *Digitalis grandiflora* All. leaves seem to accumulate more cardiac glycosides in manganese and molybdenum rich soils. Large quantity of copper in soil hinders cardiac glycosides synthesis (Grinkevitch, Sorokina, Kutcherov, 1981; Kutcherov, 1985). *Adonis vernalis* L., growing at forests' edges in more lighted conditions appears to be more active than its forest-steppe region variety. The activity of *Adonis vernalis* L. is assumed to be stable up to fruits fall (Kutcherov, Kuznetsova, 1969, Kutcherov, 1985). Consequently, for

storage purposes steppe varieties only should be used, especially in late phase (after flourishing).

Experiments on introduction of more than 40 species of officinal herbs have been made in the botanic garden, most of the plants are a success in culture (Kutcherov, Gafrasova, 1961).

Much attention was paid to the nectar productivity study of wild melliferous herbs. Nectar productivity of more than 180 species of wild melliferous herbs in many natural zones of the Southern Urals was determined for several years (1979–85). *Tilia cordata* Mill. is the most valuable melliferous plant which gives in favourable conditions upto 80% of commercial honey (Kutcherov, Siraeva, 1980, 1983).

Botanists' attention was attracted by ornamental wild plants that can be used for greenery purposes in settlements. As a result of expeditions more than 70 species of ornamentally interesting plants were found, which belong to 23 families. Due to introduction 18 species were selected and recommended for greenery purposes: *Pulsatilla patens* (L.) Mill., *Lilium europaeus* L., *Dianthus acicularis* Fisch. and others (Novikova, 1983). Methods of these species cultivation were studied and some of them began to be used for greenery. Ornamental properties are established to improve greatly during introduction: the number of flowers of the plant grows, the dimensions also increase.

Large investigations in the field of introduction of many ornamental plants were carried out in the botanic garden of the Institute of Biology of the USSR Acad. Sci. Bashkirian Branch, as well as selection of more perspective varieties to find new kinds of peonies, chinese aster and lilac (common) took place.

During the years of ornamental plants study 140 species and 200 varieties of perennial flowers were characterized. Phenospectra of the most perennial species were established to be of stable type, which is characteristic of correspondence of plants life rythms to the new environment (Avrorin, 1956; Kravchenko, 1978, 1983). Chinese peonies as ornamental plants are of particular interest. In the botanic garden there were distinguished 10 kinds from 33 being studied which occured to be the most ornamental in conditions of Bashkiria 24 perspective seedlings were obtained by hybridization, 7 of which became candidates to new varieties (Kravchenko, 1983). Two seedlings were registered by the species determining State Commission in 1985 as new kinds: "The Appasionata" — of crimson scarlet colour, "The revolution's Jubilee" — of cherry-red colour. Both these kinds are regioned in the territory of Russia.

Studies of more than 120 kinds of Chinese aster allowed to select some kinds, which are most ornamental and the most stable phusarios (Rogova, 1983).

Lilac (common) is known to be widely used for city and town greenery. Its "double" types are particularly decorative in spring during flourishing time, its dark-green leaves fall off only with frosts. Selection of lilac has taken place in the botanic garden, some of those obtained are greatly ornamental (Sakharova, Yakupov, 1968; Sakharova, 1971).

The botanists did not lose sight of fruits and berries as well as of vitamic plants. Much attention was paid to the study of *Cerasus fruticosa* (Pall.) G. Woron., of *Corylus avellana* L., of Ribes nigrum L., of *Rosa majalis* Herm. (Baikov, 1954, 1983; Muryseva, 1979). Highly vitamined and productive kinds of *Rosa majalis* Herm. have been selected, those being tested by the state quality commission now.

During last 5 years, rare and disappearing plant species of the Southern Urals have been investigated in detail. The

Southern Urals flora (Bashkirian ASSR, Chelyabinskaya, Oranburgskaya regions of Russia) has revealed 363 rare species, which amount to 22, 7% of all highest cryptogamic and vascular plants of this zone of the Soviet Union. The most of these rare species are found to grow in steppe and in rock substrated (145 species). Rare kinds varieties are being preserved in marshlands (47 species), which were not subjected to land reclamation measures. The Southern Urals high lands are rich in rare kinds (38 species) as well, where antropogene influence is less than in plain regions. Among rare species there were registered 56 relicts, 15 of which belong to the remnants of tertiary and 41 species to the pleistocene flora. Pleistocene relicts have different floristic complex belonging to rock and rock-steppe relicts of Asian origin of Late Pleistocene — Early Holocene. Endemic flora consists of 42 species 11 of them grow in high lands, 27 on rocks and rock steppe regions and only 4 in broad leaved forests zone.

Considerable number of rare species are met in 11 families: Fabaceae Lindl. (34), Orchidaceae Juss. (30), Asteraceae Dumort. (27) and others.

Introduction presents one of the ways of preservation of rare species gene fund. Biological properties of 43 rare plants species in conditions of culture are studied and methods of their cultivation are recommended (Kutcherov, 1985).

Botanic garden together with the plant resources laboratory accomplished its researches investigations of new fodder crops and silo plants *Silphium perforatum* L., *Helianthus subcanescens* (Grey) Mats., *Trigonella platycarpos* (L.) Golosk., *Crambe abyssinica* Hochst., *Angelica archangelica* L. and others.

Silphium perforatum L., *Helianthus subcanescens* (Grey) Mats. are the most productive to give from 800 to 1200 centner of greens per hectare.

Different ecotypes and wild fodder plants of types *Lathyrus, Vicia, Astragalus, Bromopsis, Onobrychis, Trifolium* were collected during the expedition period. More than 600 ecotypes had been studied, the most productive species such as *Trigonella platycarpos, Astragalus onobrychis, Vicia multicaulis* have been selected (Kutcherov, Balkov, Gufranova, 1976, Kutcherov, 1979, 1984).

Several arboreal — shrub plants exposi tions were created in the botanic garden and demonstrated in the dendrarium. More than 700 species, varieties, forms, hybrids and kinds of arboreal — shrub plants are represented by the collection fund (of the botanic garden). A good collection of Salix type has been created with 35 forms and varieties (Kuliagin, 1983). *Juglans mandschurica* Maxim., *Phellodendron amurense* Rupr. and others have been observed the most acclimatized trees of Far East wooden flora.

In the collection under green-house conditions, there are more than 500 species from Australis, New Zealand, South East Asia (India, China, Japan), South Africa, Mexico Deserts, etc. (Muryseva, 1959).

The botanic garden exchanges seed with 50 botanic gardens of the world and the Delectus is annually reported. Great part in the work of botanic garden is devoted to excursions.

About five thousand people visit the botanic garden to get acquanted with rich world of plants of the Earth.

In the nearest future there are arrangements for further reconstructing the botanic garden, as well as making new expositions.

REFERENCES

Avronin N.A. Aklimatizatsiya i fenologeya. Bu. . GBS, 16. 1956.

Baikov G.K. Cerasus frutícosa (Pall.) G. Wunsch. v Bashkirskov ASSR. Materialy pervogo Vsesoyuznogo Soveshchaniya botanikov i selektsionerov. M. L., 3. 1964.

Baikov G.K. Resursy vitaminnykh rastenij i ikh ratsionalnoe ispolzovanie. Trudy Vsesoyuznogo Soveshchaniya po vitaminam. Ufa, 1963.

Grinkewitch N.I., Sorokina A.A., Kutcherov E.V. Sodenzhanie serdetchnych glikozidov microelementov v Digitalis grandiflora Mill. proizrastayutschchey v Bashkirii. Rastit. Resursy. 17. 3. 1981.

Dikorastutschie lekarstvennye rasteniya Bashkirii. Ufa, 1975.

Klobukova-Alisova E.N. Dikie plodovye rasteniya v Bashkirskoy ASSR. Ufa. 1944.

Klobukova-Alisova E.N. Dikorastutschie poleznye i vrednye rasteniya Bashkirii. M., L., 1958.

Klobukova-Alisova E.N. Dikorastutschie poleznye i vrednye rasteniya Bashkirii. M., L., 2. 1960.

Kravchenco O.A. Selektsiya plodov v botanitcheskom sadu BF AN SSSR. Introductsiya i selektsiya dekorativnych rastenij v Bashkirii. Ufa. 1978.

Kravchenko O.A. Itogi introduktsii dekorativnych travyanistych mnogoletnikov v botanitcheskom sadu nyitnika Biologii BF AN SSSR. Resursy i introduktsiya rastenij v Bashkirii. Ufa. 1983.

Kulagin A.Y., Vidy roda Salix v Bashkirskom Preduralye i na Yuzhnom Urale. Resursy i introduktsiya rastenij v Bashkirii. Ufa. 1983.

Kutcherov E.V. Resursy dikorastytschich lekarstvennych rastenij Bashkirskoj ASSR. L. 1968.

Kutcherov E.V. Lekarstvennaya flora Bashkirii i voprosy ejo ratsionalnogo ispolzovaniya. Herba Hungarica. Budapest. 17. 1. 1978.

Kutcherov E.V. Resursy i introduktsiya poleznych rastenij v Bashkirii. M. 1979.

Kutcherov E.V. Kormovye rasteniya lugov i pastbischch bashkirskich ikh ratsionalnoe ispolzovanie. Ratsionalnoe ispolzovanie i okhrana lugov Urala. Perm. 1984.

Kutcherov E.V. Ob okhrane i obogaschchenii genofonda rastenij na Yuzhnom Urale. Ufa, 1985.

Kutcherov E.V. Vliyanie ecologicheskich uslovij na kachestvo lekarstvennykh rastenij. Regionalnye problemy ecologii. Kazan. 2. 1985.

Kutcherov E.V., Galeeva A.Gr. Opyt organizatsii zakaznikov po okhrane lekarstvennykh rastenij v Bashkirskoj ASSR. Rastit. Resursy. Ufa. 18. 2. 1982.

Kutcherov E.V., Rutrannova I.B. Dutcherov Introduktsiya nekotorykh lekarstvennykh rastenij v usloviyakh Preduralya Bashkirii. Dikorastutschie introdutsiruemye poleznye rasteniya v Bashkirii. Ufa. 1. 1981.

Kutcherov E.V., Kuznetsova N.A., Lazareva O.N. Sravnitelnoe izutchenie biologicheskoj aktivnosti Andromis veronicifolia (L.) A. Sibiricus Rupr. iz raznych punktov Bashkirii. Rastit. resursy. 5. 1. 1969.

Kutcherov E.V., Siraeva S.M. Nash gavryj medonos. Pchelovodstvo. 6. 1983.

Muryseva N.M. Kollektsiya rastenij zakrytogo grunta Botanitcheskij sad Bashkirskogo filiala AN SSSR. Ufa. 1969.

Muryseva N.M. Opyty po introduktsii Rosa Majalis Herm. v usloviyakh Bashkirskogo Preduralja. Poleznye rasteniya dikoj flory Bashkirii i puti ikh ratsionalnogo ispolzovaniya. Ufa. 1979.

Novikova L.S. Introduktsiya dekorativnykh dikorastutschikh mnogoletnikov iz flory Bashkirii. Resursy i introducts iya rastenij v Bashkirii. Ufa. 1983.

Rogova R.I. Itogi introduktsii odnoletnikh dekorativnykh rastenij. Resursy i introductsiya rastenij v Bashkirii. Ufa. 1983.

Sakharova A.S., Yakupov N.A. Krasivotsvetutschie derevjya i kustarniki dlya zelenogo stroitelstva Bashkirii. Dikorastutschie i introdutsiruemye poleznye rasteniya v Bashkirii. Kazan. 2. 1968.

Sakharova A.S. Dekorativnye derevjya i kustarniki dlya ozeleneniya gorodov Bashkirii. Dekorativnye rasteniya dlya ozeleneniya gorodov Bashkirii. Ufa. 1971.

SOUTH-CHINA BOTANIC GARDEN — THE LARGEST SUBTROPICAL BOTANIC GARDEN IN CHINA

CHEN-ZI TANG

South East China Botanic Garden, Guangzhou (Canton), China

If one gets into the mainland China by train from Hong Kong, the first large city comes into his sight is Guangzhou. It is a beautiful subtropical city with many gardens and scenery places. There are flowers and evergreen trees everywhere. The South-China Botanic Garden is one of the famous gardens near the city and has been voted by the residents of the city recently as one of the "Eight Most Scenery Places in Guangzhou". Of course, the function of this garden is not only a beautiful place for pleasure, but also an institution for botanical research, education and plant conservation.

This botanic garden was started in 1958 on the site composed of bare waste land, swamps and eroded hills. After that, the land was planned and reformed, various kinds of subtropical and tropical plants introduced and planted. And now one can no longer find any trace of the waste land before. In front of people who visit here is a garden with flowers, neat lawns, green hills, and the still water of the big artificial lake mirrored the surrounding forest of palms, conifers and trees of different tunes of green. Due to the advantageous subtropical climate, the trees here grow very fast and so some people even do not believe that this garden is only 27 years old.

Administration Building

This garden is situated in the north-east suburbs of Guangzhou, about 11 kilometers away from downtown. The situation of the garden is on 113°21' E. longitude and 23°11' N. latitude, that is 16' to the south of the Tropic of Cancer. The climate here is subtropical, maximum temperature in July is 38°C and minimum temperature in January is to −0.8 C but only sustain in a very short period. The average annual rainfall is 1600–1800 mm mainly from April to September. The garden covers an area of 300 hectares and has a varied topography. It consists of about 41.5% of flat ground, 17% of low hills, 40% of hills and 1.5% of lakes and ponds.

As a research centre of botany and horticulture, this garden is affiliated to the

South-China Institute of Botany, Academia Sinica. The main subjects carrying on in the garden are the introduction and acclimatization of subtropical and tropical plants as well as the conservation of endangered plant species. At present, there are 4800 species of plants in its living collection. The special groups are: ferns, Orchidaceae, Palmae, Zingiberaceae, Araceae, Magnoliaceae, bamboos, and medicinal plants. Most of the species are from the vast subtropical and tropical areas in China, and a small part of them are from other countries in warm latitudes by seed exchange.

According to the different functions, the garden is divided into three parts: The Experiment Area, The Display Area and The Propagation Area.

1. *The Experiment Area :* It is a piece of land with all its appropriate facilities for the purpose of doing all sort of experiments about plant introduction and acclimatization as well as the conservation of the threatened plants. In this area, such sections as the Arboretum, the fields for experimental original materials of Orchis, Zingiberaceae, Magnoliaceae, Bamboos,

The Royal Palm Avenue near the Main Gate.

Medicinal plants, Fast-growing timber trees, Endangered species, Plant species for re-establishment of the vegetation on eroded hills.... etc. are included.

2. *The Displayed Area :* It is the main part of this garden which has been landscaped and displayed with various kinds of plants introduced. This area is open to the public seven days a week. It is divided further into the following gardens :

i) *The Display Lath-houses :* A group of lath-houses linked by winding corridors to keep the collections of ferns, Begonias, Aroids, Marantaceae, Gesneriaceae and other shade-loving plants. The fernery occupies the largest lath-house with the area of 1200 sq.m. In the fern collection, the tree ferns such as *Cyathea podophylla, Brainia insignis* and the huge epiphytic *Pseudodrynaria coronans* and the Bird's Nest Ferns are very spectacular.

ii) *The Orchid Garden :* Over 500 species of orchids mostly native in China are kept here. The showy climbing species like *Renanthera, Epidendrum*...etc. cover over the top of the lath-house and the corridor. Most of the epiphytic species are grown on

Glyptostrobus pensilis growing in the "Garden for Plant Relics".

tree-fern trunks or osmunda boards. Within them,the collection of the genus *Dendrobium* is most special. The terrestrial orchids like *Cymbidium, Paphiopedilum, Phaius* .. etc. are grown in pots or on the ground. Many research projects such as the embryo culture of *Dendrobium*, the hybrid breeding of the Orchids, and the Phytotaxonomy of some of the genus of Orchids are based on this rich collection. A new orchid garden of 0.6 hectares is now under construction.

iii) *The Palm Garden* : The garden is on the peninsula just opposite the Main Gate. With over a hundred species of palms and the surrounding lake, it is a very attractive place with characteristic tropical scenery.

iv) *The Bamboo Garden* . Nearly 100 species of bamboos mostly of local origin are grown here to make a very picturesque and quiet small garden. The clump habit of the most species grown here are caespitose, so the scenery of this bamboo garden is quite distinct from those of other parts of China where the main species of bamboos are mostly with effuse clump habit.

v) *The Garden of Plant Relics* : The plant relics such as *Ginkgo biloba, Metasequoia glyptostroboides* and *Glyptostrobus pensilis* etc. which sometimes known as "living fossils" are grown in this garden. The collections of Araucariaceae, Taxodiaceae are used as background for these "relics". The beautiful *Taxodium* grove grown in the shallow water of the lake along the border of this garden is always being a target of the photographers.

vi) *The Garden of Medicinal Plants* About 700 species of Chinese medicinal herbs as well as some introduced tropical medicinal plants such as *Erythroxylum coca, Hymdocarpus anthelmintica* and *Cinnamomum cassia* etc. are grown and displayed. It is a favourite place for the people who want to learn the knowledge of medicinal plants.

vii) *The Garden of Economic Plants* About 700 species of plants used as industrial raw materials are displayed here. Such as *Abrustes toroli, Pimenta acris* and *Cananga odorata* , etc.

viii) *The Garden of Ornamental Trees and Shrubs* : Some 500 species of flowering trees and shrubs and other woody ornamentals suitable to be used in the parks and gardens in South China are grown here. Many of them are newly introduced and acclimatized by this botanic garden. Such as *Elaeocarpus hainanensis, Elaeocarpus apiculatus, Dillenia turbinata, Fagraea sasaki* and many species of Ficus...etc.

ix) *The Gymnosperm Garden* . Gymnosperms other than Ginkgoaceae and Taxodiaceae which are grown in the Garden of Plant Relics are all planted here. Most of the species are from South China. Within them, the winding gymnosperm *Gnetum* and some rare endemics such as *Fokienia hodginsii, Dacrydium pierrei* and *Podocarpus imbricatus* as well as other members of the genus *Podocarpus* are very interesting.

x) *The Cycas Garden* The members of *Cycas* was separated from the Gymnosperm Garden and established a new garden of itself recently. At present, there are only 8 different accession numbers of this group in the collection. But the characteristic appearance of these plants attracted a lot of visitors.

xi) *The Garden of Anti-pollutant Plants* : Plants proved to be resistant to air pollution are displayed in this garden.

xii) *The Pugang Reserve* : "Pugang" is the name of the hill where a natural forest is reserved. The area of this hill is only 5.2 nectares, but the component of this forest is very complicated. There are 350 species of native plants found in this forest, that is the half of the number of plant species found in the whole Guangzhou area. There are many representative species of subtropical flora within them. The rare endemic species, *Machilus oculodracontis* are firstly found in this reserve. Pugang Reserve has proved to be an ideal place for the research of the local flora and ecology.

xiii) *The Green-Houses* : Two small green-houses with the total area of 400 sq. m. are used for keeping tropical plants which are not hardy in Guangzhou, such as *Cinchona ledgeriana* and *Theobroma cacao* etc. and also the Cacti and succulents which cannot stand the rainy weather.

Some new gardens will be built in the recent coming years.

xiv) *The Water Garden* : It will be divided into two sections, the Fresh-water Garden for the plants suitable to fresh water, and the Salt-water Garden for the plants of the mangrove.

xv) *The Ginger Garden* : The species belonging to the Zingiberaceae mainly represented by *Alpinia*, *Curcuma*, *Amomum* and *Zingiber* will be displayed in this garden under lath-house as well as in the open.

xvi) *The Magnolia Garden* : About 11 genera and more than 90 species of the trees and shrubs belonging to the family Magnoliaceae will be grown in this garden.

3. *The Propagation Area* : A nursery specially used for the propagation of the introduced and acclimatized economic and ornamental plants, spared plants to other institutions or individuals as new material for cultivation. And on the other hand, this brings in some income to support the garden itself.

The South-China Botanic Garden is a very young garden in comparison with most of the botanic gardens in the world. So we still have a lot to do and to learn. We need to exchange experiences, knowledge and idea with the people who work in other botanic gardens especially in the botanic gardens in India and other Tropical Asian Countries. I think the exchange of informations, plant materials and personage between these gardens will benefit both sides.

CENTRAL REPUBLIC BOTANICAL GARDEN OF THE UKRAINE

A. M. GRODZINSKY

Central Republic Botanical Garden, USSR, Kiev 14

Central Republic Botanical Garden (CRBG) of the Ukrainian Academy of Sciences was founced in 1935 on the right bank of Dniper river in the old part of Kiev, the capital of the Ukrainian Soviet Socialist Republic.

During the Second World War Botanical Garden was completely destroyed. In 1944 the member of the Ukrainian Academy of sciences N.N. Gristko became the leader of the reconstruction and development of the Botanical Garden.

Now CRBG is a scientific-research institute of the Ukrainian Academy of Sciences; it consists of ten scientific departments, administration department, information and management services and scientific library. More then 500 persons are on its staff.

An area of 130.2 hectares of the Garden is situated on the diverse and beautiful locality. Since 1965 the Garden is opened for visiting. We have about one million of visitors annually in spring time during the big lilacs collection flowering. But the main purpose of our Garden is the broad research activity. The scientists of the Botanical Garden carry out research work on introducting in the Ukraine the plants from different regions of the Earth, breeding of useful plants non commercial varieties, improving landscape architecture and planting, ecology and allelopathy, biochemical plant evolution, mass propagating of plants for industrial growing.

Department of Natural Flora (the head of Department Dr. of bio.sc. I.I. Sikura) takes care of the following botanic-geographical sections with habitual models of vegetation : "Steppe of Ukraina", "Ukrainian Conderous Forests", "Ukrainian Deciduous Forests" "Crimea", "Carpathian Mountains", "Caucasees", "Middle Asia" "Siberia and Altai" "Far East" (from 1,5 to 6 ha each) and some experimental plots. The total collection contains 4336 species. The staff of that oldest department works on introduction and naturalisation into our condition the plants from different natural habitats of the USSR. The scientists try to introduce some endangered species into native plant communities of the North Ukraine. We have a special unit for this purpose "Rare species in flora" with 400 taxa, 250 of which are from the Ukraine (curator Ph.D. W.G. Sobko). There is a big Herbarium in Department of Native Flora. It contains over 130 thousand of specimens. 9310 species of this Herbarium relate to 1424 genera and 176 families.

The main task of the staff of Dendrology Department (the head of Department Dr. bio.sc. prof. N.A. Kokhno) is the work on the introduction of the most valuable for planting of greenery trees and shrubs of the world genofond. They use forest cultural trees and shrubs to protect the

General view of the garden with topiaries

field from pollution and pests. The collection of the Department occupies 25 ha and contains over 1700 taxa. The collection of our Abroretum is one of the richest in the European part of the USSR. The flora of the USSR occupies on the first place in the Arboretum (about 25%), the second place is occupied by the East-Asia flora (about 20%) and the third place is taken by the species of the North-America flora about 12%).

We have the largest in the USSR collection of *Acer* (75 taxa), the largest in the Ukraine collection (40 taxa), *Betula* (82 taxa,) *Berberis* (over 70 taxa), *Syringa* (23 species and 74 cultivars of *Syringa vulgaris* L.), *Magnolia* (13 taxa), Coniferae (101 species and 61 forms). The staff of the Department carried out the works on the investigation of the biological and ecological peculiarities of the representatives of the genera *Acer, Quercus, Magnolia, Syringa, Betula, Viburnum* and East-Asia and North-American conifers.

Since 1970 all ancient parks, arboretums, dendrological parks and ornamental urban

A view of the garden

plantations were studied by the collaturaturs of Department in all geographical regions of the Ukr. SSR. The specific and formal contents of trees and shrubs, subshrubs and lianes cultivated in the republic has been determined. The potentially introducible in the Ukr. SSR dendroflora includes 170 species and 176 forms of gymnosperms, 1722 species and 616 forms of angiosperms.

The main direction of the current scientific-research work of Department is the investigation of the seedling of introduced plants, the biology or ripening, peculiarities of the keeping and preparation of seeds to sowing.

The main task of Plant Acclimatization Department (the head of Department Ph.Dr. of bio.sc.P.A.Moroz) is research

Plants in bloom during spring.

work in the field of introduction and selection of southern plants and new fruit ones such as : apricot (*Armeniaca vulgaris* Lam.), peach (Persica vulgaris Mill.), wild myrobalan plum (Prunus divaricata db.), cornelian cherry (*Cornus mas* L.), actinidia (*Actinidia kolomicta* Mak., *A. arguta* Planch., *A. purpurea* Rehd.), Magnolia vine (*Schizandra chinensis* Bail.), quince (*Cydonia oblonga* Mill.). The collection was created on the territory of 12 ha. It consists of 112 species and forms of wild plant and about 1500 cultural varieties and forms of fruit plants. The plant of the different geographical regions are represented in this collection, therefore we have opportunity to create a valuable genofond for hybridization by breeding of new varieties. The selectionists of Department use in their work such methods as sowing of introduced seeds, growing the following generation species, inter crossing, obtaining of polyploid forms.

Over 100 perspective forms were cultivated and selected. These forms were passed from selection researches to the selection experimental stations, collective farms and state farms. 20 varieties were brought to the State Committee" Agroprom"

Seven cultivars have been passed to the competitive selectivity test and are introduced into classification of the districts of the Ukrainian Soviet Socialist Republic, including 6 peach cultivars (named Dneprovsky, To the memory of Shewchenko-Pamjati Schewchenko, Friendship-Druzhba, Rumjany, Slavutich, Kiev's Nectarian-Nectarin Kievskyi and one vine grape variety (named Kiev's Golden-Kievsky Zolotisty.

New cultivars of southern fruit plants are distinguished from old by higher winter hardening, yield capacity, taste quality, they have different period of ripening. These fruits are used as fresh as bottled. The results of this work are published in the (following) monographs : The staff of Department of Greenary Planting and Landscape planning (the head of Department Ph.D. o.sc. S.I. Kuznetsov) carry out the research work in planning of new and reconstructing of old botanical gardens and parks in the Ukraine, developing of the ecology landscape principles and geobiological ones used in parks and gardens created. The scientists of Department offered some principles of a new plant expositions planning : Coniferous garden, monocultural and rock ones and expositions consist of water littoral vegetation or decorative fruit plants, angiosperms (Angiospermae) plexes. The scientific workers of Department investigate quite difficult problem the peculiarities of planting of territory around the historical buildings and memorials. Many of that places were replanted and now there are many recently introduced plants. After the analyses of Kiev's historical places greenery our scientists proposed the original management of that green areas

The plant reaction on ecological changes in the condition of urban industrial districts are investigated. The scientists search on the alternative ways of intensification of industrial territories greenery planting and principles of creating the protective green plantations. The species Cedrus deodara is used for creating green plantations, forests and botanical gardens in the South of the USSR.

Department of Floriculture and Decorative Plants (the head of Department Dr. prof. N.M. Dudik) has several expositions: Climbers, Rock garden, Rosarium, Dahliarium (from 1 to 30 ha each) and the collections of annuals and perennials containing 838 species related to 332 genera and 59 families, 3272 cultivars and 144 varieties. Hybrids pool contain over 600 specimens

The scientists of Department examine the nearly introduced into our conditions and the breeding of new cultivars and varieties. The breeding of *Dahlia, Paeonia, Chrysanthemum, Gladiolus, Iris,* China aster and some bulbous plants are very successful

Department includes the seed-exchange laboratory maintaining the contacts with 551 botanical gardens of the world.

Department of Greenhouses (the head of Department Dr. T.M. Cherevchenko)

Dahliarium

has the collections of tropic and subtropic plants under glass (the area of about 6000 m²). There are 2609 taxa related to 564 genera and 119 families in the collections.

We have the first and the richest collection of orchids in the Ukraine. The scientific works of Department investigate the peculiarities of orchid morphology and work on the cultivation technique in conditions of the Ukraine. The optimal and cheap cultural medium, some substrates and other agronomical methods were developed in that Department. Some epiphyic orchids with weak geotrophic reaction of roots were recomended to use in experiments in space orbital flight. The staff of Department carry out a large work on greenery planting of different interiors (so called phytodesign).

The main direction of scientific research of Plant Physiology Department (the head of Department Dr. E.A. Golovko) is allelopathy of higher plants in various types of

Valuable genofond of fruit trees

Garden in Winter

phytocenosis. After some years of investigations very broad distribution of allelopathy in the world of plants was demonstrated. Practically each plant may be allelopathically active depending on the situation.

The vegetation in the Ukraine divided into three groups of plants, they are 1) The plants of steppe with relatively small activity, usually dominating in climax (stage). Mostly they are perennial plants propagating by seeds *(Stipa, Festuca, Koeleria, Poa)*.

2) The plants with moderate activity. We suppose they play the dominant role only at stages of succession. These plants are propagated by rhizomes *(Agropyron, Hierochloa, Calamagrostis)*. For example, some grass clumps grow with a rapid

A view of the garden with flower beds and topiary

rate about 0, 3-0, 2 mm per year and they make a dense stands. After few years a bald grade arises in the center of those clumps. The reason of that phenomenon is antointoxication.

3) Very active plants, that grow only solitary and roam perpetually from place to place because of their strong auto-intoxication. Because of high allelopathical activity they easily invade the dense plant stand. These plants are propagated exclusively by seeds (*Crambe totaria,* Sebeonk, *Adonis wolgensis* Aev.).

Investigation of more than 15 ecological mechanisms of allelopathy (Grodzinsky, 1984) shows that the main cause of allelopathical action of plants is the accumulation of organic toxic substances in soil or so

Collection of Conifers

A granstand view of garden

Germplasm of Conifierae (101 species)

called soil sickness. That phenomenon has a big practical importance for cultivation of some crops (wheat, rye, sugar beet, alfalfa, flax a.o) We developed the method of extracting allelopathical substances from soils by the use of modeling ion-exchange resins absorbing ability of plant roots.

There is very important ability of some plants to clean the field and the soil where they grow from detrimental animals, weeds and plant diseases agencies.We developed some techniques (biological methods) of cultivation without chemical pesticides. Allelopathical soil sickness caused by the intensive cultivation of wheat, flax, alfalfa, fruit trees and many other plants was searched and some methods of testing and controling of negative effects are developed. There are many methods of agricultural

biological management using allelopathic property of cultivated plants and micro-organisms applying pesticides in small proportion or without them.

Department of Medical Botany (the head of Department Ph.Dr.agr.sc.A.Ph. Lebeda) has large collection containing over 400 species of medical plants. The staff of Department investigates biochemical and pharmacological properties of medical plants used against different illness and stress agents. They carry out this work collaborating with special medical institutes and hospitals. The scientific workers of department engage on the new scientific problem-phytodesign as improvement of the human environment in interior or closed artificial ecosystems. It is necessary for human being to have the direct contact with green plants and flowers if only to feel the needs of oxygen, food, fuel and technical materials. These vital requirements are the result of man and plants

A view of Arboretum during winter

coevolution. It becomes especially strong if the person is in isolation, or in artificial and closed ecosystems for a long time. The introduction of living plants or their models into man's surroundings, especially at extreme conditions is inevitable. Here phytodesign becomes a part of Industrial Design as an adition to it.

The main functions of phytodesign are the following:

1. Satisfaction of aesthetic and psychological requirements of people by seing the diversity of forms and colours and by breathing the aroma of plants and by appreciating flowers art compositions.

2. Improvement of the air conditions of the ecosystem by photosynthesis and emission of volatile substances.

3. Action of the plant volatile substances, especially the adaptogenic and tonic ones on the physiological state of a person.

4. Optimization of the airborne surface and skin microflora by plant volatile substances.

5. Resolution of an instinct solving "trouble about our little neighbours". Taking care of plants people relax and decrease stress effect on them.

6. Warning the people for biologically dangerous situations. Sometimes the plants are much more sensitive to the action of various poisons, radiation etc. than a man.

Some apparatuses, terpene dosators were constructed in Department, that fulfil the above mentioned functions 2 and 4. In experiments with healthy people it has been found that many physiological functions of that group of people are objectively better than in control group. Using of phytodesign decreases the bacteria and microfungi amounts in the air up to 1.5-2.5 times in general and pathogenic bacterial forms up to 5 times.

The Laboratory of New Cultures has the collections of new forage plants, essential oil ones and vegetables. The staff of Laboratory works on plant introduction, selection of useful plants and the varietal plant breeding. Fourteen new cultivars have been passed on the state variety trial, seven cultivars was distributed into districts. Now these cultivars occupy the area over 250000 ha in the territories of the Ukraine, Byelorussia and RSFSR.

The main scientific direction of Laboratory is the auxiliary usage of solar radiation to protein production in forage plants during the early spring and late autumn periods.

The scientists of Laboratory investigate the native aromatic and spice plants, analyse the possibilities to change the imported spices by native ones in canning industry and to expand the assortment of new vegetables in public catering establishments.

The Laboratory of Cytology (the head of Laboratory G.P. Dogdan) was organized in 1966 on A.M. Grodzinsky's initiative.

Under the leadership of A.K. Dzievaltowsky the cytoembryological investigations of water-melon, musk-melon, cucumber and other plants were carried out. First, apomixis of diploids and experimental polyploids of Cucurbitaceae was described. The scientists investigated the reasons of hybrid sterility among hybrids of plum and apricot, wild myrobalan plum and apricot, sand cherry and apricot, chinese lilacs. The cytoembryological investigations during the selection of several species of lilacs, apricot, tulip, gladiolus were carried out. The mutants of tulips,

phloxes, lilies, roses and other decorative plants are investigated cytogenetically. The scientists searched hystochemically the influence of unfavourable environmental factors on cells and tissues of such plants as flax, clover, sea buckthorn and other. Several substances to prolong the life and decorative characters of cut carnation, lilac, roses and other flowers was created on the basis of those investigations.

The newly introduced in the conditions of CRBG plants and polyploids of different systematic groups are investigated caryologically.

The main problem of the Laboratory of Introducted Plants Protection (the head of the Laboratory Ph.D. M.D. Prutenskaya) is systematical studing of arthropoda species content, pathogenic mycofloras, phytonematods, phytoviruses and proving their biocenotic, ecological peculiarities and quantity dynamics. The scientists search for the self-regulated systems in artificial phytocenosis; investigate interrelations of plants and plant parasites; show the plants stability to harmful organisms and the factors of this stability, improve available and search for new plants protection against pests and diseases.

As a result, the fauna of insects, nematodes, mycoforas and mycoplasmas, diseases of plants introduced into the botanical gardens, floricultural industries and parks of the Ukraine are investigated. The scientific basis of plants protection against harmful organisms during plant introduction, creating stable to parasites and diseases urban green plantations and biological methods of greenhouse plants protection against phytophagous are carried out.

Central Republic Botanical Garden of the Ukrainian Academy of Sciences maintain the creative relations and exchange of seeds with many botanical establishments including the Indian ones. Indian scientists and especially botanists of Botanical Survey of India visited our Botanical Garden repeatedly to exchange the experience. There are many perspectives for further strengthen the creative relations, carrying out joint investigations, training of students and young scientists and exchange of valuable plants.

THE IMPORTANCE OF BOTANIC GARDENS FOR THE PRESERVATION OF PLANTS ENDANGERED OR THREATENED BY EXTINCTION 1

F. EBEL, S. RAUSCHERT, E. WEINERT
in collaboration with
H. G. FUHRMANN AND F. KUMMEL
Martin-Luther University, Halle-Wittenberg, Am Kirchtor-3, GDR

INTRODUCTION

During the last decades we stated an alarming information about gene erosion and, in particular about so many plant species which are endangered or threatened by extinction due to human activity.

In order to counter the depauperation of the more urgent measures have to be accomplished, such as a better protection of the endangered plants at their natural habitat, a more intensive protection of certain biotopes and an increased establishment of new protected areas (biosphere reserves, nature reserves and other protected areas) based on the red lists and the biogeographical mapping data.

It should be attempted to conserve as much as possible of the complete range of genetic diversity of species of actual or potential economic importance. Diversity is well known and comprises main patterns of 1. geographical or clinal diversity, 2. inter-population diversity or that of the local area, 3. intra-population diversity or that of the local gene-pool. Hawkes (1980) discussed seven ways at present used or under consideration of preserving diversity, as seed banks of "orthodox" seeds at low temperature and humidity, biosphere reserves, tree and shrub plantations, planting and harvesting short-lived perennials year by year, seed banks of "recalcitrant" seeds, meristem banks or in vitro cultures and seedling banks or juvenile plant banks. For wild plant preserving the establishment of biosphere reserves and nature reserves is one of the most promising way.

Biosphere reserves as nature reserves, gene parks which are small in area compared to the total distribution of the species are of a great value of inter and intra population diversity, but they are not useful to conserve geographical or clinal diversity (geographical variation) unless the species itself is of very restricted range, is a rare endemic or is a species close to extinction. But they facilitate the conservation of wild species with "recalcitrant" seeds, or for tree species with unknown reproductive or seedling biology.

It is necessary to look for further new means to contribute to conservation of the plant species.

The Botanic Gardens with their technical equipment and the scientific and gardening experiences provide a basic prerequisite to find out new methods and their application for conservation. The establishment of preserving collections, also plantations of trees, shrubs and perennials, in Botanic

Gardens proposed for this purpose during the last decade is one of the methods but with limited effects.

Plant species grown in the open field in gardens are subjected to uncontrolled pollination with the danger of hybridisation with closely related and nearby growing populations. On the other hand, in many Botanic Gardens according to their restricted areas not so many individuals of one species can be kept. Until now very little has been done to conserve populations from the wild, and most wild species at present conserved in this way consist of no more than a few genotypes. But in spite of this restriction many plant species around the world can only be preserved in future by specific methods of growing them in Botanic Gardens under controlled conditions or in tree and shrub plantations (cp. Sukopp, Trautmann, Korneck 1978, Schmidt 1978, Ebel 1979).

Ebel (1979) proposed to establish protected areas and conservation gardens for wild plant conservation in the countryside for survival of those plant species which are threatened by extinction. These protected areas or conservation gardens provide for one or a few plant species, in contrast to their cultivation in Botanic Gardens of the cities, the possibility of a growth under more suitable environmental conditions and a conservation of a greater number of individuals of the population in the field. The conservation of plant species in a more or less natural habitat close to the really natural occurrences favours at the same time the preservation of animal populations, the existence of which

The last wild living individual of Artemisia rupestris of C. Europe occurs in the nature reserve "Solgraben" near Artern.

depends on the occurrence of these endangered plants[4]. During the last 7 years we were engaged to establish such protected areas and conservation gardens in the countryside for plants which are threatened by extinction concerning the southern part of our country.

ESTABLISHMENT OF CONSERVATION GARDENS AND PROTECTED AREAS IN THE COUNTRYSIDE

Method :

A team of botanists and gardening engineers choose natural habitats in the southern part of our country where only a few individuals of the endangered plant species survived for the sampling of seed and plant material in order to propagate it in our botanical Garden in Halle. So far possible we took seeds and/or sets from many individuals for setting a more or less broad range of characters conserved of the population; the young sets were planted into the countryside before flowering to avoid an uncontrolled pollination in our Botanical Garden. Young plants possess a better capability for growth than elderly or old ones. The transfer of elderly individuals from one spot to another is less successful than our method by using young plants only for this purpose. For the achievement of a successful introduction and establishment in the environment the sets have been settled in the surrounding of the habitat of the original parental plants.

Beside of the propagation of the threatened plant species in the Botanical Garden and the planting on suitable habitats near their original occurrences the staff of the Botanical Garden has to care for and to register the re-settlement process going on in the field. Without any care — at least during the first period after planting — young plants will starve and die. A documentation of such a re-settlement assures a later correct assessment. It helps, on the other hand, gaining knowledge about further protection necessities. The care and documentation was achieved under supervision of staff members of institutions for protection of nature and of the Botanical Garden Halle according to a special caring and documentation program. The assistance of one or a few volunteers in charge of protection of nature in the countryside was very favourable. One of the main tasks during the early stages of the re-settlement is to keep them without or under low competition by plants of the adjacent area then their growth rate is much higher. There is kept a file for the documentation in the Botanic Garden and in the center for mapping the flora of GDR in Halle. Our work for plant protection is coordinated and in accordance with the program of the authorities of protection of nature in our country and, in particular of the Institute for Landscape Research and Protection of Nature, Academy of Agricultural Sciences of GDR.

The documentation ought to include the following data :

1. Species name
2. Category of endanger (regional, countrywide, Europe, world)
3. Causes for retreat
4. Statements about origin of the seeds, the sets or parts of the plants
   4. 1. Geographical site (state, district, exact locality)
   4. 2. Ecological data about the sampling plot
   4. 3. Plant sociological characters of the sampling plot
   4. 4. Number of individuals at the sampling plot
   4. 5. Date of sampling of seeds, sets or parts of the plants
   4. 6. Number of parental plants of which seeds, sets or parts of plants have been collected

A conservation garden.

4. 7. Name of the collector

5. Data about the propagation and growing in Botanical Garden

5. 1. Name and address of the Botanical Garden

5. 2. Time of sowing

5. 3. Kind of soil

5. 4. Temperature for cultivation

5. 5. Time of sets propagation

5. 6. Other remarks on cultivation methods

5. 7. Name of the gardener in charge of the cultivation

6. Data about the planting plot

6. 1. Geographical situation (state, district, exact locality)

6. 2. Ecological characters

6. 3. Plant sociological characters

6. 4. Time of planting

6. 5. Number of planted individuals (it is advisable to plant many individuals)

6. 6. Name(s) of the person(s) who planted

6. 7. Name(s) and address(es) of the caring person(s)

6. 8. Time and kind of caring, such as watering, shadowing, protection against grazing, exclusion of competition

6.9. Toopographic sketch of the planted or seeded area (so far possible)

6.10. Number of growing and dying individuals at certain intervals, also notes about vitality and health conditions

6.11. Well known and supposed reasons for low vitality resp. dying, such as animal consumption, plant diseases, drought, human impact

6.12. Self-propagation (successful self sowing, vegetative propagation a.o.)

The areas with newly settled taxa ought to be provided with a status of protection.

Now we want to report about some experiments to try the establishment of endangered plant species which are growing in Central Europe at the border of their total distribution area, here mainly in enclaves.

Selected plant species under treatment

Beside of several other examples of rare plant species in our country, as *Marrubium peregrinum* L., *Carex hordeistichos* Vill., *Arabis alpina* L., the two following species deserve a higher attention because of their rareness and the direct threat of extinction. They represent unique occurrences with at present one or a very few individuals in C.Europe only.

Artemisia rupestris L.

The small shrubby plant with numerous procumbent, non-flowering shoots and ascending flowering stems of *Artemisia rupestris* is one of the rare, phytogeographically remarkable plant species in GDR most threatened by extinction. The main distribution of this continental perennial of the steppe in southern Sibiria and C. Asia touches Europe only in S. Ural and the adjacent lowlands. Spectacular enclaves of this species occur in the Baltic region (Eesti NSV, Oland) and in C. Europe near a salt spring at Artern (southern part of GDR). One former occurrence between Stabfurt and Bernburg in C. Europe is extinct since 1929 (Ebert 1929).

Since the beginning of this century the species grows successfully only in a nature reserve at a saline field, the so-called "NSG solgraben" near Artern. During the time of 1948 to 1960 we registered about 20 strong individuals of *Artemisia rupestris* inside of a densely covered community of *Artemisia maritima* on a very slightly saline, silty soil associated with some halophytic herbs. A poultry farm established 1960 for two years in this nature reserve caused a rapid damage and decrease of the *Artemisia rupestris* individuals, so that only a few individuals on half a squaremeter have been left (Rauschert 1964, 1979.). Merxmüller and Rothmaler (1963) stated the species is getting extinct in Germany but they did not know and check the real situation in our country. Also the statement in Flora Europaea (1976) *Artemisia rupestris* reported to be formerly in C. Germany has to be corrected. The last native individual of *Artemisia rupestris* in C. Europe was growing until 1979 hidden beneath the dense *Artemisia maritima* stands near Artern. From this single plant with about 40 flowering stems and about 200 non flowering branches we gained in September 1979, fifteen parts of the plant which provided the sets for further clonal propagation in spring 1980. The young plants of this species we planted again on 8 registered small plots into the *Artemisia maritima* community (fig. 1) close to the edge of the nature reserve "Solgraben" near Artern where they are growing luxuriantly. Not far from the original occurrences near Ringleben and Esperstedt (6–7 km west of Artern), in addition, we introduced juvenile plants of *Artemisia rupestris* from our Botanical Garden.

Salix bicolor Ehrh. ex. Willd.

This willow (*Salix bicolor*) belongs to the *Salix phylicifolia* group which is distribu-

led in Europe and W. Asia from the sub-meridional/montane to the arctic zone. It occurs in the mountains of Europe from C. Europe to N. Spain and the Balcan peninsula but not in the Alps, where *S. hegetschweileri* Heer represents the group.

In our country *Salix bicolor* has its native occurrence close to the highest peak of the Harz Mts., the so-called Mt. Brocken. F. Ehrhart discovered in 1789 here the species and distributed only male plants as herbarium specimens. The following botanists and observers, as Hampe (1861), found only female individuals. It must have been very rare at the begining of this century because Drude (1902) noted that *Salix bicolor* occured only at the upper northern slope along the path to Ilsenburg.

In 1962 only one known individual was existing in the neighbourhood of the Brocken-Hotel. We were informed in 1980 this single plant might have been destroyed during levelling the habitat. Regrettably our sample, from the time before, as set from this native wild plant we cultivated in 1962 in our Botanical Garden Halle died in 1978. A second set of the same origin we gave in 1962 to Mr. Walter Meusel for his arctic/alpine garden in Karl-Marx-Stadt but we did not suppose that later on in 1980 we have had to ask him to give us some branches for a further clonal propagation in our garden. Young plants of this material could then be planted now again not far from the Brocken massif near the so-called Zeterklippen (alt. 929 m ast.) in a fenced and protected field, which may be called a conservation garden (fig. 2). It grows here on a windblown and dry habitat in the upper montane spruce forest zone. Additionally we established conservation gardens at two other localities on a wind protected habitat and on a more moist soil near a riverlet. These experiments were necessary because we did not know the optimum requirements of this taxon which is already extinct in nature in our country. The planted individuals growing since 1981 and 1982 display a good development and a more successful growth than those under garden conditions inside the city.

We hope to keep this last and unique genotype of Salix bicolor at the Brocken massif in nature. This plant supposed to be a certain infra-specific taxon of *Salix bicolor* of its own, therefore this kind of protecting and conservation measures seem to be particularly justified. The conservation garden for wild plants in the vicinity of Mt. Brocken in C. Europe was prepared by the protection of nature authority in Wernigerode and the forestry department in Ilsenburg in co-operation with the Botanical Garden of Halle-University.

ACKNOWLEDGEMENTS

We are much indebted for generous support and encouragement to Prof. Dr R. Schubert (Director of the Botanical Garden Halle), H. Aschenbach (Ringleben), H. Eckardt (Benneckenstein), W. Fricke (Artern), H. Maizis (Esperstedt), W. Meusel (Karl-Marx-Stadt), H. Quitt (Wernigerode), K. Rornhardt (Elrich), J. Röth (Halle) O. Sieber (Artern), and the Institute for Landscape Research and Protection of Nature of the Academy of Agricultural Sciences in GDR.

REFERENCES : Buschendorf, J. Ebel, F. &Tauchert, K. H. Biogeographische Kartierung in den Stadtkreisen Halle, Halle-Neustadt sowie im Saalkreis. Mitt. aus dem Botanischen Garten der Sektion Biowissenschaften Halle Nr. 48. Naturschutzarbeit in den Bezirken Halle und Magdeburg 16 : 111 IV. 1981.

Drude, O. Der hercynische Florenbezirk. Leipzig. 1902.

Hupl, F. Die Bedeutung der Botanischen Garten für Landeskultur und Naturschutz. Mitt. aus dem botanischen Garten der Sektion Biowissenschaften Halle Nr. 40. Wiss. Z. Univ. Halle, math.-nat. R. 28, 95-105, 1979.

Ebel, F. und S. Rauschert, unter Mitarbeit von F. Kummel und H. Schmidt. Die Bedeutung der Botanischen Garten für die Erhaltung gefährdeter und vom Aussterben bedrohter heimischer Pflanzenarten. Arch. Naturschutz u. Landschaftsforsch. 22, 187-199, 1982.

Ebert, W. Flora des Kreises Bernburg und der angrenzenden Gebiete. Bernburg, 1929.

Hampe, E. Betrachtungen über den jetzigen Bestand der Flora des Harzgebietes. Ber. Naturw. Ver. d. Harzes i. d. Jahre 1859, 1860, 59-61, 1861.

Hawkes, J. G. Genetic Conservation of "Recalcitrant Species" — An Overview. In: Withers, L. A. and J. T. Williams [ed.]: Proceedings of an International Workshop held at the University of Reading, UK, 1980. Crop Genetic Resources: The Conservation of Difficult Materials. IUBS Ser. B 42, 83-91. Paris, 1980.

Hering, E. M. Bestimmungstabellen der Blattminen von Europa. 's-Gravenhage, 1957.

Meusel, H. and W. Rothmaler. Floristic Regionation in Germany. Webbia 18, 211-236, 1963.

Meusel, H., Jäger, E., Rauschert, S. & Weinert, E. Vergleichende Chorologie der zentraleuropäischen Flora 2. Jena, 1978.

Perring, F. H. Conservation of seed of rare species. Cunningdon, 1975.

Rauschert, S. Zur Flora von Thüringen I. Wiss. Z. Univ. Halle, math.-nat. R. 12, 710-713, 1963.

Rauschert, S. Zur Flora Thüringens und der nordlich angrenzenden Gebiete. Wiss. Z. Univ. Halle, math.-nat. R. 13, 651-653, 1964.

Rauschert, S. Zur Flora von Thüringen 8. Beitrag. Wiss. Z. Univ. Halle, math.-nat. R. 21, 59-60, 1972.

Rauschert, S. Verbreitungskarten mitteldeutscher Leitpflanzen. 13. Reihe. Wiss. Z. Univ. Halle, math.-nat. R. 21, 7-68, 1972.

Rauschert, S. unter Mitarbeit von Benkert, D., Hempel, W., Jeschke, L. Liste der in der Deutschen Demokratischen Republik erloschener und gefährdeten Farn- und Blütenpflanzen (hrsg. vom Kulturbund der DDR, Zentraler Fachausschuß Botanik), 1979.

Schmal, P. Der forstbotanische Garten Tharandt und Probleme der Landeskultur und des Umweltschutzes. Wiss. Z. Techn. Univ. Dresden 27, 1349-1351, 1978.

Schulz, A. Über die Ansiedlung und Verbreitung halophiler Phanerogamenarten in den niederungen zwischen Bendeleben und Nebra. Mitt. thüring. bot. Ver. 31, 1-129, 1914.

Sukopp, H., Trautmann, W. & Korneck, D. Auswertung der Roten Liste gefährdeter Farn- und Blütenpflanzen in der Bundesrepublik Deutschland für den Arten- und Biotopschutz. Schriftenreihe f. Vegetationskunde 12, 1-138, 1978.

NOTES: 1. Publication of the Botanical Garden of the Martin-Luther-University Halle No. 99.

2. Angelica palustris (Bessert. Hoffm., a European-West Siberian species reaching eastward to the Altai Mts., is rare in C. Europe.

THE BOTANIC GARDEN OF GIESSEN — THE OLDEST UNIVERSITY GARDEN IN THE FEDERAL REPUBLIC OF GERMANY

GERHARD GOTTSBERGER

Botanisches Institut und Botanischer Garten, Universität Giessen, 6300 Giessen, FRG

The first university gardens were founded in Italy, such as 1545 in Padua, 1547 in Pisa, and 1567 in Bologna. Dutch and German universities followed: 1577 in Leiden, 1584 in Jena, 1593 in Heidelberg, and 1609 in Giessen. The much older Botanical Garden of Cologne, first mentioned in 1490, was soon given up and used otherwise. Since the Garden of Heidelberg is not at its original place any more — it has been shifted twice and newly arranged — the credit falls to the Botanical Garden of Giessen to be the oldest botanical university garden in the Federal Republic of Germany, which is still at its first location (von Denffer 1959, Gottsberger 1984, Schultka 1984).

It started with a patch of the landgrave's old palace garden: In 1609, the landgrave Ludwig V of Hessen donated 1200 qm thereof the newly founded university for the purpose of laying out a 'Hortus medicus'. This was the basis for one of the most unique German botanical gardens, outstanding for its age and stock of trees, and, according to Ernst Küster, one of the early directors of this garden, it had to be classed within the most beautiful botanical gardens in Germany. Even the landgrave called it his most 'precious treasure'.

The Botanical Garden of Giessen was founded in a period, when botany was an emerging science, which was the time of describing mainly medicinal plants, culminating in the herbal book of Hieronymus Bock (1539) and Leonhart Fuchs (1543). Therefore, it was only logical that the first director of this garden, Ludwig Jungermann (1609-1625), had to be a Professor of medicine as well as botany, and quite familiar with the science of medicinal herbs. He was renowned to be an expert in botany and left a herbarium of over 2000 specimens. It was he who published the oldest German local floras, which naturally included the Flora of Giessen. He also protected the garden through a high wall against stray cattle and probably the mischivous youngsters in order to guarantee the undisturbed growing of the plants.

The 30 Years' War caused fundamental changes. Landgrave Ludwig moved the University of Giessen to Marburg (the University of Marburg had been transferred to Kassel), which however was reversed in 1650. In the meantime the Botanical Garden was partly dilapidated and was hardly looked after. Up to 1817 the formerly aspiring garden seemingly played a minor role in university affairs. We only know of a few incidents: In 1699 the construction of a coldhouse for frost-sensitive plants is mentioned, and in 1720 the first 'glasshouse' was built. Since 1773 we find the name 'Botanical University Garden' instead of 'Hortus medicus'.

Early in the 19th century a forestry, for the purpose of demonstration and instruc-

Glass house and general view

Tropical house with giant water lilies and aroids.

tion was layed out right beside the Botanical Garden. The ruinous exploitation of the woods during the 18th century and the lack in qualified foresters had diminished the forest areas in Germany. This trend had to be. stopped which was the main reason for this forestry in Giessen. Johann Bernhard Wilbrand, the second official director of this garden (1817–1846) succeded to unite forestry and Botanical Garden. Due to his efforts in the following years the garden area reached its present spread. The foresters moved out and founded the first German faculty of forestry.

Since Liebig's assumption of office at the University of Giessen, the chemical laboratory had been transferred to the present 'Liebigstrasse', an incident which raised Wilbrands hope for a further increase of the garden area. His successor, Alexander Braun first on the professorial chair of botany in Giessen and one of the most famous botanists of his time, only

A vista of the garden


Cacti and succulents

stayed 8 months and followed a call to Berlin. He evidently found the garden in a quite run-down state and, because of his limited stay, was not able to realize his plans for a modernization. But his successor, Hermann Hoffmann (1851–1891), the founder of phenology, then intensively took care of the maintenance of the Botanical Garden.

Meanwhile, botany had emerged rapidly as a science, thus influencing the development of the Botanical Gardens. Up to then the collecting of an extensive body of plants for the sake of instruction and scientific studies had been the main aim. Now, it deemed more important to give a good survey on plant kingdom to the student. Therefore, the former 'Hortus medicus' became the 'Hortus systematicus' which, influenced by the worldspanning journeys of Alexander von Humbold, was to develop into the 'Hortus geographicus'

Credit is due to Adolf Hansen (1891–1920) who modernized the Botanical Garden during his tenure with the help of F. Rehnelt, his garden inspector. Hansen says: 'The transplantation was a huge body of work. The result was not only the arrangement of plants according to systematic aspects, but also an elegant and stylish layout.' The new greenhouses and the hibernian house were an enormous gain, since now a lot of interesting tropical and subtropical plants could be cultivated and thus demonstrated to the students. During this period the Botanical Garden in Giessen reached the standard to be expected of a modern university garden.

During Ernst Küster's directorship (1920–1951), the tradition of the Botanical Garden was continued with the active support of H. Nessel, a well-known garden inspector.

The Second World War stopped this development. Due to the lack in personnel the garden dilapidated and was partly destroyed in 1944 during an air raid. After the war Küster started to rebuild the damaged garden, which was continued by Dietrich von Denffer (1951–1976) and his garden inspector G. Schönfelder. In the early 50's the greenhouses were restored and enlarged, amongst them a warm-Water-greenhouse which had been planned already by Küster. Some sections were altered and were newly equipped, such as a 'Historical section' and a 'Genetical-Biological-Demonstrations section'. From 1976 to 1982 Rudiger Knapp was in charge of the Botanical Garden. During his tenure important innovations took place, e.g. a new greenhouse arrangement which now houses the collection of tropical economic plants, orchids and insectivors.

The Botanical Garden of Giessen, rich in tradition, had its 375th anniversary in 1984. During the long period of development it passed through different phases of formation. The former 'Hortus medicus' is represented again in the section of medicinal and poisonous plants, and plants with special secondary compounds. The 'Hortus systematicus' is integrated in the section 'System of higher Plants' while the 'Hortus geographicus' is an attraction to visitors because of its similarity to the natural biotops. Considering the progressive destruction of nature, such arrangements of plants are not only informative, but have already preserved endangered species from extinction on earth.

ACKNOWLEDGEMENTS

My thanks go to H. Felle and J. Silberbauer-Gottsberger who kindly corrected language and style and to J. Döring who prepared the photographs.

REFERENCES : Denffer, D. von: 350 Jahre Giessener Botanischer Garten. Giessener Hochschulblätter 7 (3), 6 pages. 1956.

Gottsberger, G.: Vom Kräutergarten zum Park. Botanische Garten mit Tradition – 375 jähriges Jubiläum in Giessen. DAAD Letter 1984 (3): 16-19. 1984.

Schäfer, W.: 375 Jahre Botanischer Garten der Universität Giessen – ein Botanischer Garten im Wandel der Zeiten. Giessener Universitätsblätter, Heft 1: 19-31. 1984.

KINGS PARK AND BOTANIC GARDEN

P. R. WYCHERLEY

Kings Park Board, West Perth, Western Australia 6005

EARLY HISTORY

About 15 km from the mouth of the Swan River on its northern bank stands Mount Eliza, little more than 70 m high it is hardly a mountain even by Australian standards, nevertheless it is a commanding eminence overlooking the river and coastal plain. De Vlamingh probably found the fresh water spring at its foot on 11 January 1697 and the French explorer Heirisson certainly climbed Mount Eliza on 18 June 1801, although it was not until 8 March 1827 that it was given that name by Stirling during his preliminary investigation two years prior to the founding of the Swan River Colony. Aboriginal place names and folklore testify to the significance of this vicinity long before European settlement.

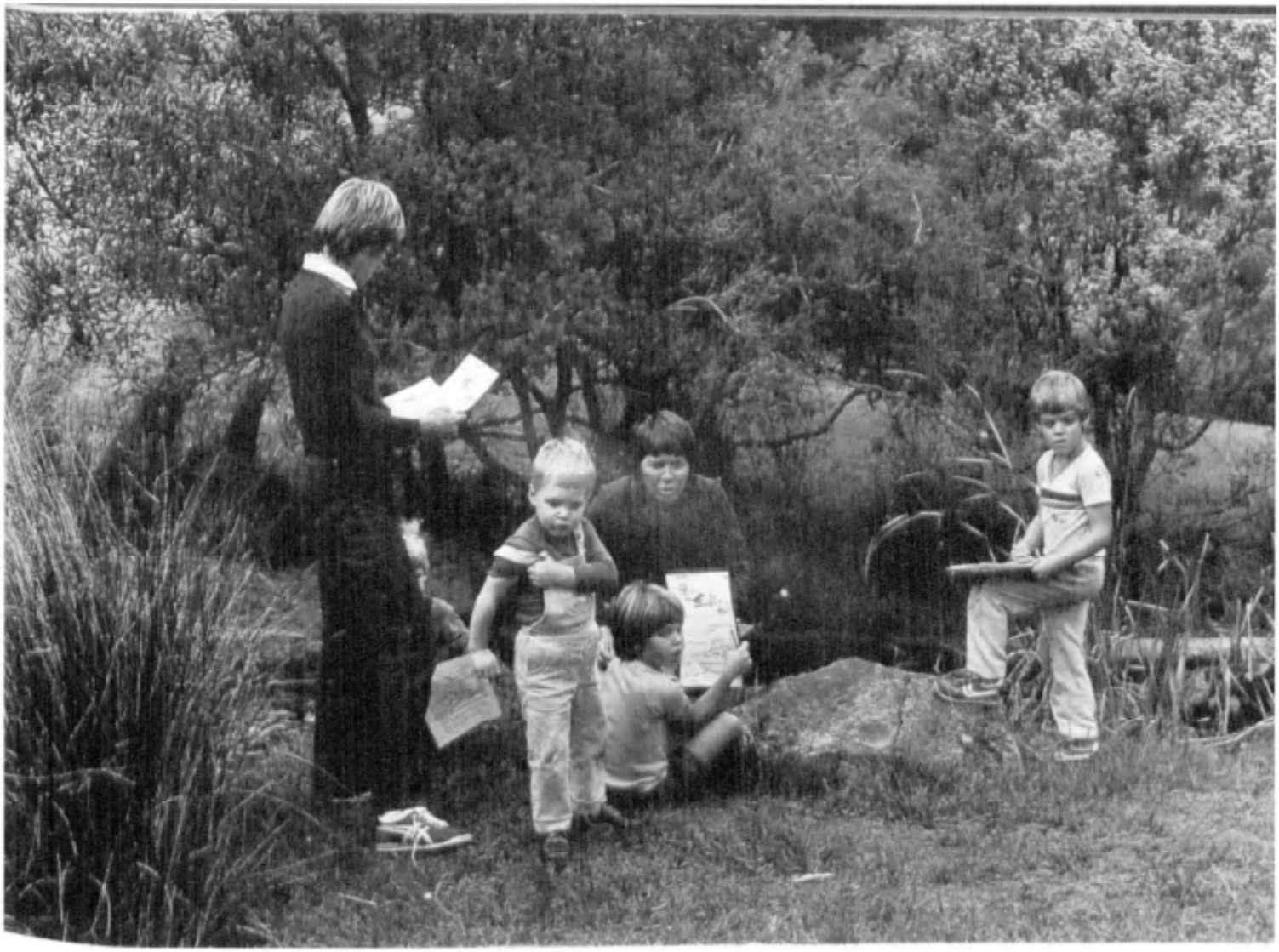
In January 1831 just nineteen months after the first settlers arrived the first Surveyor General J. S. Roe indicated that Mount Eliza and its environs would be reserved for public purposes, presumably parkland. However, it was not until 1 October 1872, when much of the original timber had been cut, that the first part of the present Kings Park was gazetted as a reserve. Most of the rest of its present extent of 400ha was reserved in 1890. Active development began in 1895 under the leadership of Sir John Forrest the first Premier of Western Australia and President of the Park's Board of Management. The name was changed from Perth Park to the Kings Park to mark the accession of King Edward VII in 1901.

THE PARK

The original concept seems to have been to create an English style public park with lawns shaded by standard trees and driveways flanked by avenues. Many of the trees planted upto 90 years ago still survive as splendid specimen trees, *eg.* figs, pines and palms. Others have been lost, for example a magnificent avenue of Western Australian Red Flowering Gums *(Eucalyptus ficifolia)* succumbed to an epidemic of Patch Canker disease.

The early plantings were a mixture of Australian, including Western Australian, species and introduced materials. The characteristic Mediterranean type climate, — hot dry summers and cool moist winters — combined with the strongly drained sands (over limestone in places) of Kings Park to make lush lawn establishment practically impossible without expensive irrigation, which was moreover technically difficult until modern pumps and bore equipment became available. Consequently, whatever may have been the intentions of the founders, more than two thirds of Kings Park remains bushland to this day.

A number of commemorative features and recreational facilities typical of the Edwardian Period were established in Kings



Participating in the Children's Holiday Activities Program in the Botanic Garden, Kings Park.

Park. English Oaks and Planes nostalgically planted along memorial drives did not flourish and were later replaced by Eucalypts. The learning process was sometimes painful and some early introductions have bequeathed problems still with us today.

Brachychiton populneus, a tree introduced from north and east Australia, has become naturalised in the bushland, but not in plague proportions.

Veldgrass, *Ehrharta calycina,* and some other introductions from South Africa, including some ornamental geophytes, have become serious weeds in the native bushland of Kings Park.

THE BOTANIC GARDEN

The other five States of Australia have inherited Botanic Gardens from the Victorian or Colonial Period. However, it was not until the 1950's that the lack of a botanic garden in Western Australia was realised as an important deficiency, although relics of some earlier plant introductions gardens remained. It was decided in 1959 to establish the State Botanic Garden in Kings Park and work began in 1962. It was agreed to concentrate on bringing into cultivation the native flora of the South West of the State, where the rate of endemism is high (about 70%). Nevertheless, some smaller sections were included to display plants from other regions of the world which shared a Mediterranean climate with Perth, namely the littorals of Southern Europe, Northern Africa and Asia Minor, the Cape of South Africa and California, also parts of South Australia and of Chile. These "allied" floras include plants of horticultural potential for Perth, related species and ecological equivalents or analogues, the latter are not

always close taxonomically. The total area of the Botanic Garden is 17 ha of which 14 ha is devoted to the flora of Western Australia. There are also several Arboreta, including the original specimen tree plantings. Established irrigated Arboreta and Feature Gardens cover about 26 ha and a further 5 ha are being developed on land returned to the Board by former tenants. In addition there is a 13 ha bush or unirrigated arboretum.

The Arboreta and Gardens are backed up by an extensive Nursery, and Experimental Section of nearly 1.5 ha. Propagation shade and glass houses and frames cover 2300 m^2 Recently a further 600 m^2 in a complex of four Display Glasshouses has been opened to the public. These enable visitors to see plants which cannot be grown in the open ground of Kings Park for various reasons. Many Eremean Region or desert plants can tolerate frost, which very seldom occurs in Perth, but not winter rains; an ambient temperature, but low watering regime house is provided for these.

The complex includes two heated or tropical houses, one for ferns and epiphytic plants is kept humid, the other is kept relatively dry for the plants of spinifix grasslands for example. The fourth of these Display Glasshouses is cooled in summer to extend the period when carnivorous plants, such as the Western Australian endemic genera *Byblis* and *Cephalotus*, can be seen at their best. There is also a collection of halophytes in this house, some of which are of economic importance in the pastoral rangelands. Cycads are a feature of the central courtyard of the complex.

Native Plant Display in Kings Park. Colour variants of *Anigozanthos manglesii* with *Macropidia fuliginosa*, *Chamelaucium ciliatum* and *Verticordia chrysantha* grown and displayed in containers.

The Display Glasshouses have brought the number of species grown and displayed permanently (or regularly in the case of annuals) in Kings Park to nearly three and a half thousand. About half of these are Western Australian including many of the endemics of the South West. More than two-fifths of the species gazetted as rare and endangered flora in Western Australia are in cultivation in Kings Park and Botanic Garden. The main omissions in the representation in the collections of Kings Park of the flora of the South West Botanical Province are those plants, especially trees, which require heavy or clay soils with a high water holding capacity. The Board hopes to establish an annexe on a very suitable site in the vicinity of Wungong Brook south east of Perth. This would enable a more extensive representation of temperate species also.

RESEARCH AND INFORMATION

Since the inception of the Botanic Garden in Kings Park twenty four years ago various aspects of the biology of the Western Australian flora have been investigated. Many of the species now grown had not been cultivated before and the propagation of most plants, whether from seed or vegetatively, was initially on an experimental basis. Natural habitats and vegetation were studied to assist in providing suitable conditions under cultivation. Colour variants and cultivars

The sandplain section of the Botanic Garden in Kings Park. *Anigozanthos rufus, A. pulcherrimus, Callistemon phoeniceus* and *Eucalyptus macrocarpa*.

The Donkey Orchid *Diuris longifolia* with *Sowerbaea laxiflora* in the bushland of Kings Park.

exhibiting particular characters were selected. For example the Red Flowering Gums with adequate resistance to or tolerance of the Patch Canker Disease to survive through the original epidemic attacks have been multiplied and preserved by grafting onto Marri stocks.

As progressively more species are brought into cultivation, some more refined methods have to be devised for the more difficult to propagate, many rare and endangered species falling into this category. A micropropagation unit has been set up. It has been used for rapid multiplication of colour variants, for example some Kangaroo Paw *(Anigozanthos)* hybrids by tissue culture. This technique has been applied successfully to an increasing list of rare and endangered species, including some now coming under commercial pressure, for instance both of the carnivorous *Byblis* species. Most of the Western Australian terrestrial orchids have now been successfully germinated in axenic culture with their mycorrhizal symbionts. There is, however, more work to be done on growing them on and transferring to open ground in gardens or bushland.

Two-thirds of Kings Park is still native, even if not pristine, bushland. As in most other regions where a Mediterranean type climate prevails, fire is a factor in the natural ecology and is also one of the perturbations induced by man accidentally or as part of management. Fire and weed invasion are two problems in the management of urban bushland reserves, which, by force of circumstance, Kings Park is well placed to investigate. Prospects of controlling veldgrass have recently

improved significantly with the introduction of highly selective grass killing herbicide formulations.

The bushland and the gardens are educational resources. Some ten thousand schoolchildren join in programs based on the Education Centre in Kings Park each year. An honorary volunteer group, Kings Park Guides, conduct parties of visitors on tours through Kings Park and Botanic Garden including the labelled Nature Trail in the bushland. An abundance of birds, especially parrots and honey-eaters which are among the most characteristic Australian avifauna, can readily be observed in bush and gardens. About one fifth of the flora of the South West is pollinated by birds. This is an obligate relationship in the case of the Kangaroo Paws.

The Display Botanist is engaged in the preparation of interpretative literature and maintenance of correct labelling throughout Kings Park. A working herbarium and modest reference library serve as tools for identification of the plants displayed and of the sources of seed exchanged through the *Index Seminum* with botanical institutions throughout the world. The State Herbarium is however located in the Department of Agriculture Headquarters in South Perth

Kings Park is active also in horticultural education and advice. For the past twenty years an intake of four student gardeners have each year commenced the three year Certificate in Horticulture course. All the professional staff, especially those engaged in research and interpretation, are called upon from time to time to give instruction both within and outside Kings Park. There has been a marked interest in the cultivation of native plants for domestic, amenity, rehabilitation and now commercial purposes. This has arisen largely out of the need for low cost gardening in both public and private premises, especially regimes with low irrigation needs as water becomes a scarcer resource and more expensive commodity due to the demands of a growing human population, but low labour and fertilizer requirements are attractive also. Consequently a full time Horticultural Advisor was appointed eight years ago to provide an extension service through personal interviews, lectures, correspondence and advisory literature.

The interpretative and extension services are in great demand, especially during the Annual Native Plant Display and Wildflower Exhibition mounted each Spring, the main but not sole flowering season in the South West. Several hundred species are grown and shown in containers to demonstrate to the public what is available. Uses of the flora, not least in arts and crafts, are also illustrated in the context of an overall conservation theme.

CONCLUSION

Although the active horticultural history of Kings Park began only ninety years ago and the Botanic Garden was established less than a quarter of a century ago, valuable advances have been achieved in conservation of the flora. These may be measured in the number of species, especially the rare and endangered, propagated and brought into cultivation, of technical problems solved, and in the amount of information given to schoolchildren, trainees, visitors and gardeners. They may also be measured less easily, but in a manner of more lasting significance, by the motivation towards conservation that the preservation and maintenance of substantial areas of bushland and gardens close to the State Capitol City centre has stimulated in successive generations of visitors.

ROYAL BOTANIC GARDENS, HAMILTON, CANADA

A. P. PATERSON

P O. Box 399. Hamilton, Ontario, Canada

ROYAL BOTANICAL GARDENS — HAMILTON, ONTARIO, CANADA

Latitude	:	43 17 N
Longitude		79 52 West
Altitude	:	115 – 233 m
Climate	:	Continental, moderated by proximity to the Great Lakes. Temperatures: July Maxima & January minima are in the +30°C to −25°C range
Average Precipitation	:	840 mm (710 mm rain, 130 mm snow)
Average Sunshine		2050 hours
Area	:	800 ha (2000 acres)

Royal Botanical Gardens grew out of the City of Hamilton Parks Board during the late 1920's & 30's. A Royal warrant was requested and in 1941 (significantly chosen as the centenary year of the Royal Botanic Gardens, Kew) the Royal Botanical Gardens Act was passed by the Government of Ontario.

RBG is an independent, autonomous organisation, a "cultural institution in which research, education and amenity is based upon the world of plants". It is administered by a volunteer Board of 24 members representing all levels of government and local citizens. There is a permanent staff of some 80 members augmented by some 60 temporary, usually summer workers.

Dr. Norman W. Radforth, a palaeobotanist and Head of the Department of Botany at McMaster University, was named the first Director in 1946. He was succeeded in 1953, by Mr (later Dr.) Leslie Laking. The present Director is Allen Paterson, N.D.H., M.Ed., F.L.S.

A Membership Association of the Gardens consists of some 2,600 persons of which 300 are particularly involved as members of RBG Auxiliary, a volunteer body: active in educational and promotional aspects in the community.

Funding: The annual budget is now in excess of $3m p.a. Through the Ontario Ministry of Citizenship & Culture (responsible for museums and allied institutions in the province) operating grants of almost 50% of the budget are obtained. 30% comes from the two Regional Municipalities in which the Gardens properties lie with the balance being "earned" through rentals, membership fees and donations.

Royal Botanical Gardens is fortunate amongst organisations of its kind, in its holdings of natural lands. At the northern end of the Carolinian Forest Zone, the undeveloped parts comprise tracts of primary and secondary forest, meadow

Trillium erectum, Red Trillium.

and marshlands and open water. Diversity is accentuated by the Niagara escarpment (in its simplest form, an 80 m limestone cliff) of which RBG possesses some 3 km including a 30 m waterfall.

Biologically, the Gardens offer habitats to a wide range of native plants and animals. Flowering plants comprise some 750 species; 251 birds (migrant species 62, breeding 89) were recorded in a recent two year study and there are resident populations, amongst the larger mammals, of white tailed deer, red fox and coyote. The waters hold a recorded 38 species of fish.

Some 40 km of maintained nature trails are available to the public and an active interpretive programme is conducted in parts of the natural areas with maps and guide leaflets being provided to visitors.

The proximal position of these lands to a large urban population however, presents special challenges for their management in order to sustain and enhance the rich diversity of native flora and fauna found therein. In 1975, the Board of the Gardens adopted the following policy objectives for Cootes Paradise the largest (800 ha) of our total conservation properties (1,000 ha)

i. "First and foremost, to maintain this water and marsh habitat with contiguous lands as a wildlife sanctuary, by protecting the integrity of habitats for a rich variety of flora and fauna through a firm stand on all activities which interfere with diverse ecological interaction and militate against such a preservation policy.

ii. To provide limited public access and interpretative facilities for public education and quiet appreciation only to an extent consistent with objective No. 1. above

iii. To continue to provide reasonably natural aquatic and terrestrial habitats for studies in environmental science by students at all levels."

These objectives remain today as the guides for actions respecting Cootes Paradise and for all the natural areas.

Pursuant to the writing of management plans for our natural areas (underway in early 1986), is an understanding of these ecosystems. For the past two years intensive survey work has been undertaken under the direction of our staff Environmental Biologist.

Living plant collections form the basis of a botanical garden while the degree of documentation of plants in the collections, determines their usefulness for education and research. The original horticultural background of the Royal Botanical Gardens is reflected strongly in its living collections, which consist primarily of plant groups that are of particular interest to the gardening public, to landscape architects and the nursery trades industry. Some 35,000 taxa are in cultivation in the following designated areas.

The Arboretum includes such diverse collections as flowering crab apples, lilacs, magnolias and rhododendrons as well as native trees and shrubs of Ontario. Avenues of boulevard trees, flowering trees, weeping trees and hedges demonstrate plants for special purposes. The Pinetum and the Synoptic Shrub Collection are new collections under development.

The Rock Garden developed in the 1930's from a disused gravel pit is the floral tour de force, planted with 90,000 tulips in spring which are replaced by a kaleidescope of colourful annuals in summer in a mature setting of trees and shrubs. The Rock Garden area also features flowering


Hendrie Park

cherries. A relatively mild microclimate makes possible the success of many plants otherwise tender in this area.

Hendrie Park adjacent to RBG Centre, holds several significant collections planted for visual effect and convenience of study. These include

Roses - The best modern hybrid roses for the climate of Southern Ontario with supportive groups of species, primary hybrid and historic roses. New cultivars are continually added for trial purposes.

Clematis - A definitive collection of hardy species and primary hybrids especially of the *Viticella* and *alpina* groups has recently been installed.

Hendrie Park also contains Woodland, Scented and Medicinal Gardens and areas set aside for summer annual trials.

The Laking Garden holds RBG's herbaceous perennial collections concentrating upon hybrid Bearded Iris, herbaceous and *suffruticosa* peonies (both of which are supported by species collections) and upon "border" perennials displayed in informal island beds.

The Under Glass Collections depend upon three main aspects. The public areas of RBG Centre are used to display a wide range of "house-plants" under hydroponic and conventional systems and orchids in flower are brought out for display from a recently established collection. This concentrates upon species and hybrids from the New World. Most recently a major greenhouse complex has been added (opened to the public March, 1986) whose theme is Plants of Mediterranean climates.

A concern with most Botanic Gardens is to demonstrate as wide a diversity of the world's flora as is consistent with the mandate of each. Here at RBG, in a continental climate, a reasonable aim is to grow plants under glass which cannot succeed outside. Equally it is sensible to grow those which are at their best when our outdoor collections are at their least interesting.

Mediterranean plants are an obvious answer. In addition, as winter temperatures do not have to be maintained at tropical levels, energy consumption is not high.

There are also valuable botanical and educational rationales. Interesting comparisons became possible between plants of very different families which have become adapted to similar conditions; this is greatly extended when floras of northern and southern hemispheres are compared.

RBG CENTRE

The eastern, original wing of RBG Centre, was built in 1957. Its pillared portico looks down the main vista of the Rose Garden in Hendrie Park. The east wing now houses the scientific and administrative activities of RBG.

In 1979 a new public wing was opened - an impressive building, of glass and concrete.

The interior of the Centre houses a multi-level foyer with its collections of tropical plants, as well as changing displays of flowers and art works, the library, seminar and lecture rooms. A versatile auditorium seats 500 people, where flower shows, chamber music, symphony concerts, films and lectures are held. This is available for rent by private organizations, clubs and individuals for receptions, lectures or other special events, when not required by RBG. There are fully equipped kitchen facilities for caterers' use. The combination of


Laking Garden

reception rooms and plantscaped foyers provides a setting unique in the Province.

Finally, the Floral Art Gift Shop open throughout the year is run by RBG Auxiliary. The shop contributes substantially to RBG's income.

The library serves as a research tool for RBG staff, a lending library for RBG members and members of associated plant societies,and a resource facility for visitors.

An extensive collection of books, periodicals and pamphlets is available on most aspects of natural history.

An up-to-date *Gray Herbarium Index* provides references to all scientific names for higher plants in the New World published since 1886.

A collection of over 7,000 nursery and seed trade catalogues is maintained as well as a growing collection of approximately 16,000 colour transparencies.

The library hosts monthly art exhibitions of artists whose work relates to the natural world.

In addition the Centre for Canadian Historical Horticultural Studies was established at the Royal Botanical Gardens library in 1979 with endowment funds from the Dunington Grubb Foundation.

The purpose of the Centre is fourfold

to function as a national repository for literature, documents and artifacts relevant to the history of Canadian horticulture;

to collect biographical information on Canadian horticulturists, plant breeders, nurserymen, landscape designers and others, amateur as well as professional, who have made a significant contribution to horticulture in Canada;

to collect and compile information on cultivar breeding and selection and introductions of Canadian origin,

to collect information on similar collections held by other institutions and individuals

EDUCATION AT RBG

At RBG Centre, at the Nature Interpretive Centre and at the Children's Garden, Royal Botanical Gardens offers a variety of courses and demonstrations explaining and promoting plant culture, plant study and other aspects of the natural world.

Instruction about plants is available at all levels for people of all ages. A new educational programme is planned, printed and distributed each year

A few general headings of the courses, lectures and demonstrations offered for education, continuing education and recreation follow

Arts and Crafts
Botanical Studies
Children's Programmes
Field study in Horticulture and Natural History
Flower Arranging
Plant Propagation
Nature Courses
Therapy Through Horticulture
Indoor Plants

Outreach Ontario, a programme supported by the Ministry of Citizenship and Culture and a major part of the educational activities at the Gardens since 1974, continues to make it possible for RBG (along with several other cultural institutions) to extend

educational services throughout the province. Speakers trained in horticulture, floral arts and natural history are prepared to travel to any part of the province to present talks, demonstrations and workshops to institutions, clubs or service groups on any of more than seventy lecture topics. During 1985, more than 281 public lectures were delivered under the auspices of Outreach.

Exhibits pertinent to the activities of a botanical garden are made available for airs and festivals. Plant Specialists are always available to provide horticultural advice to everyone from homeowners to city parks boards.

The **Nature Interpretive Centre** was opened in 1968; the Centre is located in the Arboretum, adjacent to the Cootes Paradise Nature Sanctuary. It has a large exhibition area which features a variety of displays depicting the natural world; terraria, aquaria and a number of live animals. Approximately 10,000 children annually enjoy school programmes at the Centre; an additional 1,500 take part in adult, family and group programmes.

The Centre offers instruction in natural history to preschoolers and seniors alike and acts as information centre for nature walks and trails in that part of the Gardens.

PROGRAMMES

Preschool	Preschool teachers are instructed in the use of kits (designed by Nature Centre Staff) which help young people to explore the natural world.
Elementary School	A variety of topics, covering the k-8 curricula throughout the year. *Nature walks and studies of* trees, birds, geology and the weather are some of the activities. A Maple Syrup programme is held in March in conjunction with RBG's own sugar maple *(Acer saccharum)* "bush" (a term denoting forested areas where the tree is dominant).
High School & Post Secondary	Special programmes can be designed to suit individual class needs relating to any area of the Gardens.
University	Several staff members contribute to courses at McMaster University and the University of Toronto.
Clubs	Junior Naturalists (8-12 year olds) Discovery Club (13-16 year olds) (Both meet bimonthly on Saturdays throughout the school year.)
Groups	Organized groups may book a guided walk or an evening presentation during the school year Canoe tours are available as well.
Families	Guided walks on Sunday afternoons

A view of the garden

and occasional Saturday evenings) are fun and learning for family groups. These include *tree identification, wildflower observation* and "Owl Prowls"

The Nature Centre is open to the public 7 days a week throughout the year

The Children's Garden is a 6 ha (15 acre) Garden, situated in Westdale, Hamilton, and lies adjacent to Cootes Paradise Sanctuary. Teaching programmes were introduced there in 1947

A Teaching complex includes nature trails, classrooms, a passive solar greenhouse and a diversity of plant taxa. Other educational tools include display plots featuring new methods of cultivation, novel vegetables and plant families as well as annuals and perennials.

PROGRAMMES

1. *School groups at the elementary level* are taught with an emphasis upon children with special needs
   Horticulture — Crafts — Natural History
2. *Junior Gardener's Club* is for 8-13 year olds
   — basic gardening technique flower arranging
   — food preparation — horticrafts
3. *Discovery Club* is for 13-16 year olds Develop knowledge of natural world as well as leadership skills
4. *Gardening Programmes* for the General Public
   Family or Group instruction (including apartment dwellers) Garden plots at RBG along with tools can be rented

HORTICULTURAL THERAPY AND PROGRAMMES FOR THE DISABLED

Royal Botanical Gardens has been providing leadership in 'Hort Therapy' since the 1960's

In 1975 the programme was expanded to include people in nursing homes and psychiatric facilities. The training of other interested health professionals was also initiated at that time.

The addition of a wheelchair-accessible greenhouse has allowed expansion of programmes for adults and younger students. Clubs from institutions visit the Garden for monthly workshops. Training sessions for students in occupational therapy and recreation are presented regularly with more than 100 similar programmes now flourishing throughout Ontario.

Wheelchair accessible boats and wagons are available for tours of garden areas of these special groups.

A Field House Garden Club was initiated in 1983 to enable disabled adults to develop horticultural skills, discuss and solve gardening problems and to participate in horticultural and horticraft workshops. This club meets Thursday afternoons.

The Horticultural Therapy Association provides monthly training sessions at the Children's Garden for health professionals.

RESEARCH AT RBG

While it is considered at RBG that the demonstrable plant collections are, per se, on going research in that many of the taxa are of unknown capability in this climate, more formal work is also of note. Taxonomic research, particularly upon the

Gentianaceae and the genus *Syringa* (of which RBG's collection of species and cultivars is the largest in the world) has resulted in many publications serving as standard references on identification, distribution and nomenclature. These include new descriptions and keys of confirmed and newly recognised species. Taxonomic work is supported by an herbarium of some 80,000 specimens.

Plant breeding at RBG has concentrated upon *Syringa*, especially within the *pubescentes*, *Iris sibirica*, shrub rose hybridisation in a search for winter hardiness and evaluation of certain native plants (notably *Hamamelis virginiana* and *Cephalanthus occidentalis* for amenity use. A plant introduction programme is in place in association with nurserymen within the province.

New selections, from breeding programmes at cooperating institutions as well as little-known species, representing groups ranging from annuals to trees, are continually received for evaluation.

GREEN TREASURE OF THE GOURD-SHAPED PENINSULA, AN INTRODUCTION OF TROPICAL BOTANIC GARDEN XISHUANGBANNA

XU ZAIFU

Xishuangbanna Botanic Garden of Tropical Plants, Mengla, Yunnan, China

INTRODUCTION

There is only one botanic garden in the tropics of Yunnan Province, China, which is the Xishuangbanna Botanic Garden of Tropical Plants. The garden is situated in the Xishuangbanna Dai Autonomous Prefecture of southern Yunnan which has vast area of tropical dense forest. The inhabitants involve many minority nationalities, of which the Dai people are the majority in number.

The garden, constructed by the late Professor Cai Xitao in 1959, is located in a gourd-shaped peninsula surrounded by a branch of Mekong River, Luosuo. Covering an area of 1,000 ha, possessing diverse types of tropical vegetation and distributing three blocks of Menglun Nature Reserve nearby, the garden has been proved as an ideal place for introducing tropical plants from abroad and home, and for conserving the rare and threatened plants of the tropics of Yunnan ex situ since its establishment.

Twenty-six years of hard work has resulted in the emergence of the garden in the dense forest. Before 1970, it was attached to the Kunming Institute of Botany, Chinese Academy of Sciences. Thereafter it became the Yunnan Institute of Tropical Botany, CAS, at the same time, it is a botanic garden. Now a centre of research has been formed in the garden for introducing, acclimatizing, exploring and protecting tropical plant resources. About 3,000 species of tropical plants have been cultivated in living collections, trial blocks of economic plants, and many facilities available for scientists, plant collections and public education etc. have been constructed in the garden. With beautiful scenery and substantial scientific content, the Gourd shaped Peninsula has become the green treasure of the tropics of Yunnan Province.

THE LIVING COLLECTIONS

The conservation of rare and threatened plants in situ is the most efficient way of species protection in the world, however if the conservation of a species in its natural habitat proves to be impossible in the long run, the cultivation in botanic gardens or in other habitats must serve as an auxiliary measure. Therefore in the recent years, the emphasis on the conservation of rare and threatened species has been put into the long term planning of the garden since the great increases of deforestation and threatened species in the tropics.

The establishment of various living collection in the garden is mainly to serve as a centre for collecting the native tropical plants especially the rare and threatened species to meet the protective needs and scientific purposes. There are twelve special

living collections established in the garden and about 1,700 species of the native flora have been planted in the collections, for instances southern Yunnan plants, palms, bamboos, tropical conifers, shade-plants, aquatic plants, exotic plants, oil-bearing plants, aromatic and medicinal plants, tropical fruit trees, tropical fast-growing trees and firewood trees.

In palm collection 65 species of the family have been planted, of which 25 species are native, a representative scenery of tropic could be found there. There are about 80 species of bamboo, 90% of them are collected from the Xishuangbanna prefecture; so the bamboo collection has been considered as an ideal garden for the protection and research of the family in southern Yunnan. In shade-plant collection there are about 200 species of the native orchid to be cultivated under shed, most of them are epiphytic thus making it as one of the most interesting places in the garden. Especially the collection of southern Yunnan plants was set up in the place where the remains of tropical rain-forests and monsoon forests covering an

The garden surrounded by a branch of Mekong River, Luosuo, the hanging bridge spanning the river leads to the garden

area of 50 ha and encompassing 1,300 species of the native plant occur. The collection was designated as a site of ex situ conservation for the rare and threatened southern Yunnan species, in which both natural scences of tropical rainforest and approximately 30 endangered species of plant requiring urgent protection in China could be seen.

THE TRIAL BLOCKS OF ECONOMIC PLANTS

The newly developed island biogeography (MacArthur & Wilson, 1967; Francesco di Castri & Lloyd Loope, 1976) demonstrated us that the limited area of fragmentary ecosystems of nature reserves and botanic gardens could not ensure most species from danger and/or extinct in the long run. And as the World Conservation Strategy mentioned that the vicious circle by which poverty causes ecological degradation which in turn leads to more poverty can be broken only by development. Conservation must therefore be combined with measures to meet short term economic needs (IUCN/UNEP/WWF, 1980). Therefore we have not only to see these problems from the angle of species protection itself but also keep the regional development planning in mind in order to improve the regional environment available for the survival of species.

The establishment of several trial blocks of economic plants was considered for domesticating the native economic potential plants, acclimatizing exotic economic plants and searching some measures of development of these plants suitable to the regional development in order to reduce the living resources essential for human survival and sustainable development being destroyed or depleted as far as we can do.

Hundreds of species/varieties of economic plants have been introduced and tested

The main gate of the garden


The palm collection

since the establishment of the garden. Of which a few species/varieties have been extended to the tropics of China in great area after getting good results, e.g., Mang-sai-long a fine variety of pomelo *(Citrus grandis),* selected from the local ones, Ylan-ylan *(Cananga odorata),* amomum *A. villosum* and *A. villosum var, xanthioides)* and Gmelina *(G. arborea)* etc. Some more the native species are being tested, a few of them may be expected to become new cultivated crops in the near future, e.g., *Rauwolfia yunnanensis, Maytenus hookeri, Gloriosa superba, Homalomena occulta* and *Calamus gracilis* etc. Cultivating exotic and native economic plants in a great quantity not only can help the development to the regional economy, it can also contribute directly to the preservation of these species concerned by spreading them widely in cultivation.

Studies have already shown that shifting cultivation and monoculture are not suitable to land utilization of tropics. Through 25 years study in the garden, we have found that the development of agroforestry ecosystems is the most rational measure of exploitation for the tropics on land uses. Among them planting tea *(Camellia sinensis*

The bamboo collection


The aquatic collection

var. assamica) under rubber plantation *(Hevea brasiliensis)* are the most succesful pattern of the ecosystems for the monsoon tropics, which has been developed up to 10,000 ha in the tropics of China and gained great benefit to economic, ecological and social aspects. Others may be mentioned as rubber+amomum, rubber+cinchona (*Cinchona ledgeriana),* rubber+rauwolfia *(R. vomitoria)*+Homalomena *(H. occulta)* and planting tea/amomum under natural forests by means of clearing the under storeys. The increased food, wood and other production from the same pieces of land, and the decreased water and soil erosion, and the improvement of microclimate effects in stable agroforestry ecosystems will solve the urgent problem of integrating nature preservation with development (IUCN/UNEP/WWF, 1980) in tropics.

THE RESEARCHES AND AVAILABLE FACILITIES

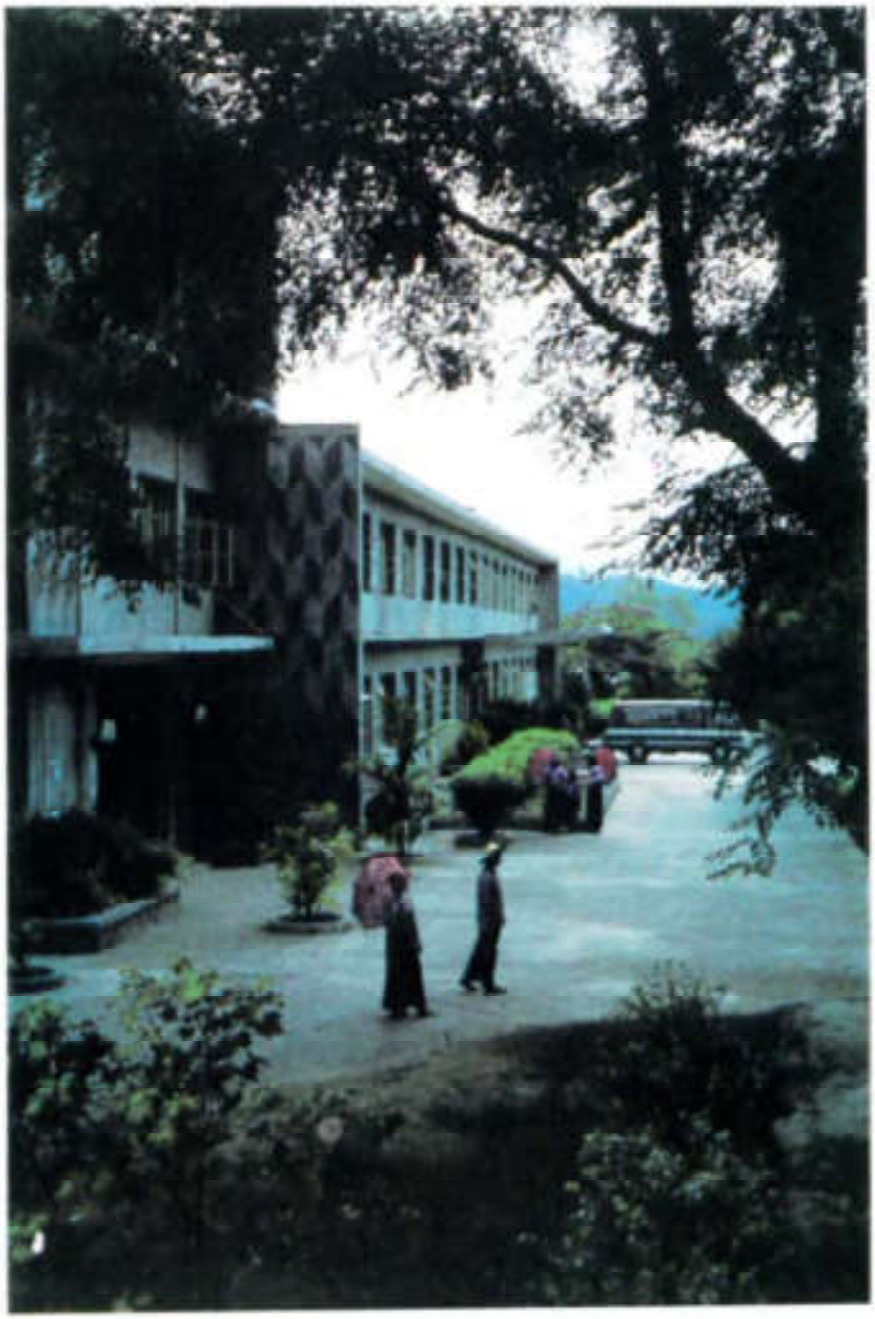
The exploitation, utilization and protection of tropical plant resources are of the responsibilities of the institute as well as the garden. Its researches have been focussed on taxonomy of tropical plants, ethnobotany, tropical forest ecosystems,

Rubber+tea experimental community

experimental plant useful chemical composition, tropical plant introduction and acclimatization, etc. according to the scientific task of the garden.

In order to fulfil all our researches, many facilities available for scientists have been constructed in the garden besides the establishment of the living collections and the trial blocks of economic plants. A small herbarium has about 50,000 specimen of plant, of which the flora of Yunnan tropics are the majority in number; the library has collections of about 35,000 books which mainly covers literature of tropical botany, tropical crops, forestry, ecology, and phytochemistry etc.; some research laboratories such as phytochemistry, physiology,

The main building, research centre of the garden



pedology and cenarology are well equipped in order to meet most of all our research work, and moreover, a small climatic observation station and a constant station for the observation of the secondary succession of tropical rainforest are set up in the garden as well

In recent years, the botanic garden has modified its traditional roles and begun to play a vital part which is the conservation of rare and threatened plants of the tropics of Yunnan owing to the loss of our half of forest. Hundreds of plant species have been threatened in the tropics since 19bOs. In order to serve us a wider range of habitats for different rare and threatened plants ex situ conservation, the establishment of a few small satellite gardens in different climate zones of the tropics have been considered in the long term planning of the garden.

REFERENCES : Francesco di Castri and Lloya Loope "Thoughts on the Biosphere Reserve Concept and its Implementation, Selection, Management and Utilization of Biosphere Reserves-Proceedings of the US-USSR Symposium on Biosphere Reserves. 137-46 1978

IUCN/UNEP/WWF "World Conservation Strategy. IUCN-UNEP-WWF 1980

MacArthur and Wilson "The theory of Island Biogeography. Princeton Univ Press. Princeton, N J 1978

Pei Shengji "Botanical Gardens in China. Univ of Hawaii Press. Honolulu. 32 35 1984

Xi Zaitu (compiler) "Xishuangbanna Botanical Garden of Tropical Plants. The Botanical Gardens of China. Science Press. Beijing China. 210 224 1981

THE CENTRAL BOTANICAL GARDEN OF THE ACADEMY OF SCIENCES OF THE GEORGIAN SSR

M. A. GOGOLISHVILI

Central Botanical Garden, Tbilisi, USSR

The botanical garden was founded in 1636. It is situated at a height from 433 to 563 m above sea level. Relief is rugged; climate, continental; soils, deep, underlain by sandy loam.

There are various geographical sections in the garden: Caucasian, East Georgian, West Georgian, Mediterranean, North American, East Asian, Talyshian, Far Eastern and European Floras and separate plant groups, such as light forest, pine grove, cedar grove, dendrological park, parterre and arboretum. The collection includes 2300 species and forms of trees and shrubs. Besides, there are about 2000 species and varieties of flowering plants, among them 400 varieties of roses. The tropical greenhouse includes over 900 varieties of tropical and subtropical plants. The garden contains six departments and one laboratory and one sector: 1. Plant Introduction and Selection; 2. Decorative Horticulture and Floriculture; 3. Medicinal Plants, 4. Agrotechnics; 5. Botanical and Nature Conservation, 6. Scientific Technological Information and its Application, a physiology laboratory and an ornamental sector. Besides, the garden has two branches in Kutaisi and Zugdidi. All these departments carry out research on the following problems:

a) Plant introduction and adaptation; b) The research of bioecological, physiological and other features of the introduced plants; c) Problems of laying out parks, tending and landscape gardening.

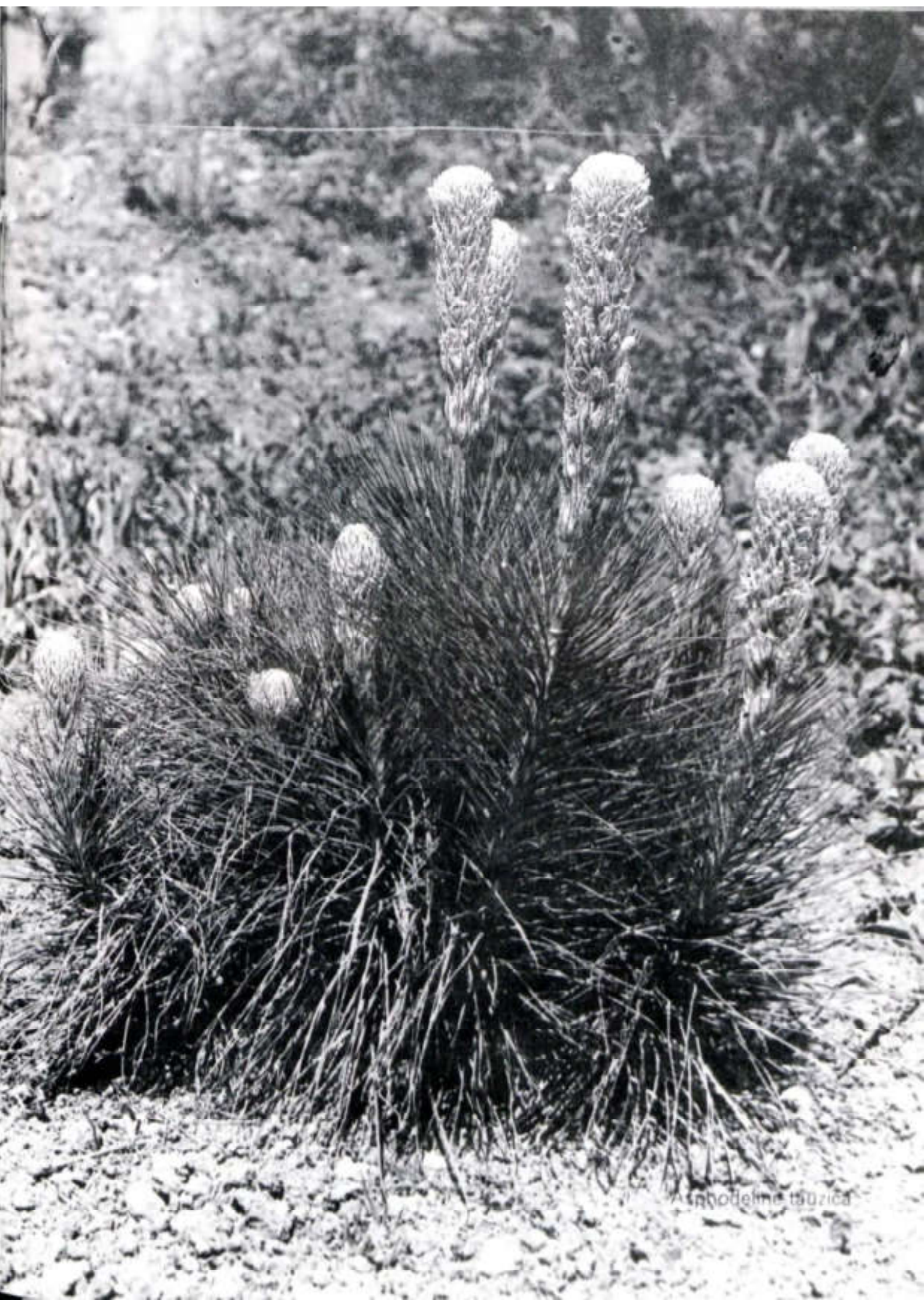
The wild herbal plants have been cultivated in the garden for 40 years. At present the collections contains 360 varieties of plants. The rare and threatened plant collection contains 90 species. Plant pests are under study and measures of pest control and combating conifer-beetles are being taken to raise the entomoresistance of the introduced plants.

The garden has connections with 230 scientific institutions of foreign countries exchanging scientific publications and seed catalogues.

At present the botanical garden serves as the Transcaucasian botanical gardens, uniting 13 botanical institutions. It coordinates scientific thematics, organizes joint sessions, joint expeditions, meetings, etc.

Paeonia lagodechiana

A view of the Central Botanic Garden, Tbilisi, Georgia, USSR


Asphodeline taurica

elleborus caucasicus

Iris iberica

Paeonia wittmanniana

Cacti and Succulents

THE TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE, TRIVANDRUM, INDIA

A. ABRAHAM

The Tropical Botanic Garden and Research Institute, Trivandrum

The United Nations Conference on "the Human Environment" held at Stockholm in 1972, made many valuable recommendations. Among these was a specific resolution that a *chain of Tropical Botanic Gardens* should be established with adequate staff and suitable funding so that the plant wealth of the world could be properly exploited, at the same time ensuring preservation of valuable germplasm for the use of future generations. In India the first response to the above recommendation was made in 1979, after preliminary studies by expert committees, by the establishment of the Tropical Botanic Garden and Research Institute. While the formal Government of Kerala resolution on the above was made towards the end of 1979, and the Institute was registered as an autonomous body in December 1979, it was only in 1982 that the necessary land in a suitable location was fixed in consultation with the Department of Forestry, and the actual transfer of land was made towards the end of 1983. The main consideration in choosing the site was reasonably certain availability of water throughout the year. Fortunately we could get a plot of land surrounded on three sides by a perennial river, which did not dry up even during the unprecedented drought Kerala experienced in 1983. Also the area is on the main trunk road connecting Trivandrum and Shencottaha, passing through undulating hills of Western Ghats.

After getting soil survey and contour maps done and availability of ground water at various locations investigated we could plan the lay-out of the garden and decide the locations of essential laboratory buildings, green houses, Orchid houses, visiting scientists' guest house etc. In this work we were greatly helped by Mr Fleigner, Assistant Curator of the Royal Botanic Garden, Kew, Surrey, England, who spent one month with us and discussed various aspects connected with the development of the garden in the immediate future, say fifteen to twenty years. Mr Fleigner is coming again in October 1986 to help us further with our training programme and some related matters.

In the last two years we have made tremendous progress, which has astonished visitors who had earlier seen the area.

The importance and usefulness of botanical gardens has been realised by all the developed countries of the world to such an extent that many of them have scores of such gardens each.

It is somewhat astonishing that some of the most famous botanical gardens in the world are located in temperate climates, the floras of which areas do not compare in their variety or luxuriance with the natural vegetation in tropical countries with bright

sunny days and good rainfall. Ofcourse, the more affluent countries of the world are also in the temperate or semi-temperate regions and therefore from early times they could afford to indulge in the luxury of growing plants in controlled glass-houses and carry out research on many of them. The results of such work have benefited also mankind in other parts of the world. The contributions of the Royal Botanic Gardens at Kew in the United Kingdom in collecting tropical plants and propagating them in their glass-houses and later spreading them in their colonies in the tropics account for the vast expansion of many cultivated plants of great economic importance. The collection of seeds of the Para rubber plant *(Hevea brasiliensis)* from Brazil, and their propagation first at Kew and later at the Botanic Garden at Heneratgoda near Colombo, accounts for the vast expansion of the cultivation of this plant in many tropical countries. One may wonder how modern civilisation could have developed but for the elastic properties of rubber! That is only one example of what a scientific botanic garden can achieve in promoting human welfare.

The main objectives of our garden and Institute are as follows :

1. to make a comprehensive survey of the economic plant wealth of Kerala

2. to conserve, preserve and exploit the plant wealth of Kerala

3. to introduce, cultivate and culture plants of India/other countries with comparable climatic condition for the economic benefit of Kerala and of India

4. to carry out botanical, horticultural and chemical research for plant improvement and utilisation

The begining of a large Arboretum

5. to offer facilities for the improvement of ornamental plants and to propagate them in the larger context of establishing nursery and flower trade

6. to organise germplasm collections of economic plants of interest to the State in the case of those species for which separate centres are not already in existence.

7. to establish a model production centre for translating the fruits of research to public advantage leading to plant-based industrial ventures

8. to engage in activities, conducive to help botanical teaching and to create public understanding of the value of plant research in general, and the need for preserving our plant wealth

9. to establish an Arboretum in approximately half the area of the Garden, with representative specimens of trees of Kerala and India, and trees of economic value introduced from other tropical areas of the world.

10. to establish a garden consisting of medicinal plants, ornamental plants and various introduced plants of economic or aesthetic value

11. to establish laboratories for botanical, horticultural and chemical research, with the aim of improvement and utilisation of plants of medicinal and ornamental value

12. to prepare a Flora of Kerala

The visiting scientist's guest house (Landscaping still in progress)

13. to establish tissue culture facility with special reference to the improvement of seeds/fruits/flowers and quick and easy propagation

14. to organise breeding for plant improvement and production of hybrid seeds, in the case of species for which such facilities are currently lacking or inadequate

15. to be engaged in garden planning and research

16. to serve as a source of supply of improved plants not readily available from other agencies

17. to do chemical screening of plants of potential medicinal importance

18. to work in collaboration with similar Institutes in India and outside, and

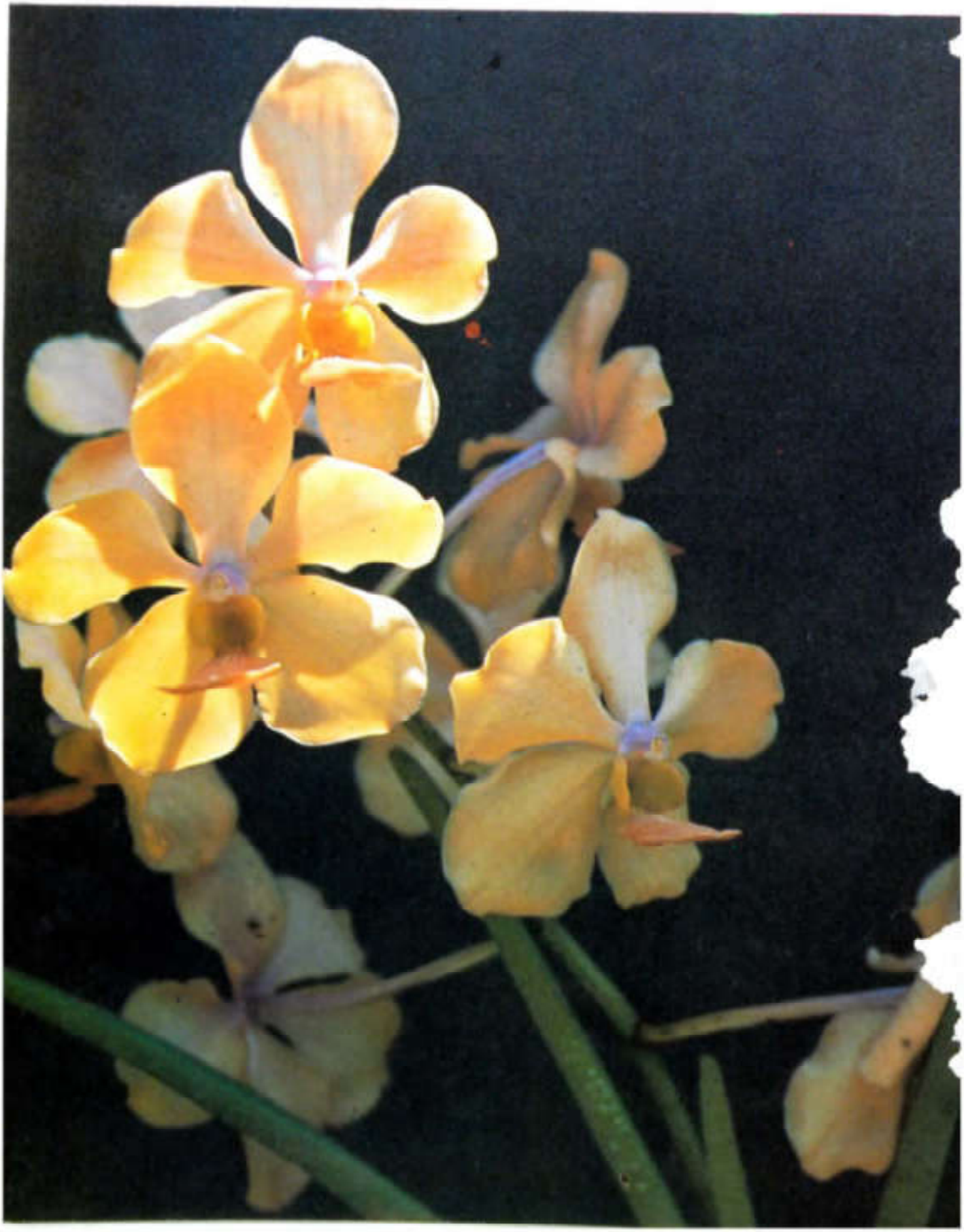
19. to promote and establish modern scientific research and development studies relating to plants of importance to India, and to Kerala in particular

In this connection it is of interest to note some of the comments made by a panel of distinguished scientists appointed by the National Academy of Science of the United States in 1975.

The panel while recommending 36 plants, selected from among 400 nominated by plant scientists around the world, for wider propagation and introduction to other countries, has among other suggestions observed as follows :

Different stages of cattleya hybrid seedings in flasks.

Vanda "Mandai Maestro"



"Throughout history man has used some 3,000 plant species for food; atleast 150 of them have been commercially cultivated to some extent. But over the centuries the tendancy has been to concentrate on fewer and fewer. Today, most of the people in the world are fed by about 20 crops-cereals such as wheat, rice, maize, millet, and sorghum; root crops such as potato, sweet potato, and cassava; legumes such as peas, beans, peanuts (groundnuts), and soybeans; and sugarcane, sugar beet, coconuts, and bananas. These plants are the main bulwark between mankind and starvation. It is a very small bastion.

Yet as the prospect of food shortage becomes more acute, people must depend increasingly on plants rather than animals for the protein in their diet. To help feed, clothe, and house a rapidly increasing world population, it is timely to consider neglected or little-known plant species.

Man has only just begun to take stock of the chemical and genetic possibilities in the plant kingdom. Now we must scrutinize the thousands of plant species, many of which are still untested and some as yet unidentified.

Most agricultural scientists are unaware of the scope and potential offered by tropical botany. *The discipline suffers largely because the major centres of scientific research are located in temperate zones.*

A view of imported Dendrobium hybrids in the orchid house

Vanda "Howell Mundell"

There is an urgent need for plant researchers to become acquainted with tropical plant life. Important new products such as oils, gums, and waxes for industry; proteins for food and feed; and chemicals for pest control — are likely to result from their attention.

The variety of tropical plant species is staggering. Contained among them is a wealth of new products. In studying tropical economic botany it is not enough to consider solely traditional needs and markets. New raw materials also will be required in the future. Changing conditions are already creating demands for new products from previously underexploited plants; more will be needed as pressures increase for the exploitation of renewable resources.

Orchid hybrid seedings in pots in the Orchid house

A massive effort is needed to ensure the survival of endangered plant species throughout the world. It comes as a surprise to most non-botanists to learn that one out of every 10 plants is either extinct or in imminent danger of extinction. Over 20,000 species are now in need of protection. Wanton destruction of natural vegetation is killing many, but the relentless spread of conventional agriculture displaces and destroys many others. Careful preservation and thorough cataloguing are particularly important for little-known plants such as those described in this report. Only in this way will be genetic diversity and healthy stock needed for developing new food crops be assured. Potential breeding stocks, clones, and cultivars will otherwise become extinct. *To this end, the number of botanic gardens, field stations, and habitat reserves containing natural vegetation types must be increased."*

PRESENT STATUS OF WORK IN THE GARDEN

The medicinal plant garden, with over 700 species including several rare plants, is already reckoned as one of the finest in South India. Additions to the present large collection are being constantly made and before long we expect to cross the thousand mark as far as number of species is concerned. Combined with the above, we have as part of the work of the biotechnology division, programme for the multiplication by tissue culture of rare medicinal plants has been taken in hand and our physicians practising indigenous medicine may soon be able to get correctly identified plant materials not easily obtained through usual sources.

Dendrobium "Heang beauty"

PLANT INTRODUCTION

Regular plant collection trips to different parts of the Western Hill ranges and nearby areas is a feature of the garden work. During these trips over 600 living specimens belonging to 250 species and more than 1200 specimens for the Herbarium were collected.

Three hundred and thirty seven live specimens belonging to 159 species/ varieties were purchased from nurseries, institutions and private gardeners and introduced into the garden.

In the large orchidarium we have over 600 exotic hybrids introduced from Singapore gardens. There are also over 300 wild species collected from different parts of India. A second Orchidarium will be completed in 1986 and the natural species moved into that.

The Herbarium which houses the Bourdillon — Rama Rao collections (1700 sheets) made in the last century and early part of this century is a valuable starting point for a very large herbarium of South-East Asian plants. It is interesting to examine herbarium sheets identified by famous taxonomists like Gamble and Fischer with notes in their own handwriting, and still remaining in good condition.

Among the more rare but unfortunately less cared for species are 35 species of *Ficus*, from the popular pipal to the extraordinary *Ficus krishnae* with its pouch-shaped leaves. "There are other plants which are familiar in folklore! the thapasa-tharu *(Balanites roxburghii)* under which Sri Rama is said to have spent his first night of vanavasa (days of exile in forest), and the 'thanni *(Terminalia belerica)*' under which, it is believed, Nala and Aswaparna exchanged 'aswapridaya' and 'akshahridaya'

Among the more endangered groups are the Cycads, which flourished over 200 million years ago and formed a dominant part of the vegetation of our flora, when Dinosaurs roamed the forests. Now only 10 genera are living, and that too restricted to some parts of the globe, South Africa perhaps having the largest number of species of *Encephalartos*. In India we have native to the country only 2 species of *Cycas*. We have succeeded through the help of Kew and the Brisbane Botanical Garden and Mr Len Butt of Queensland to add three more genera and several species to our already existing collection of four genera and nine species. We have yet to add *Stangeria*, *Lepidozamia* and *Microcycas*, which we hope to get very soon, so that all the genera may be represented in our Cycad collection.

The above is only a brief summary of the work continuing in our effort to bring plants of rare botanical and aesthetic value to our country and make it a centre from which, as they are multiplied, we could supply to other gardens. We have already brought out an *Index Seminum* consisting of 593 plant species coming under 120 families. This has encouraged active interest in seed exchange with other Botanical gardens of the world.

ORCHIDS

This group has received special attention as the author has been working on it for the last twenty years and has published from the Institute the result of his labours conducted in the Kerala University Department of Botany. Those interested in South Indian Orchids could get copies of the book from the Director of this Institute.

There are many other activities initiated already though we have been at this only for less than three years. With the dynamic leadership of the present Director, Professor A. N. Namboodiri, and a small band of young enthusiastic scientists, it may be expected that this tropical botanic garden in the southern tip of the Indian subcontinent may in a few years become a centre of attraction to visiting scientists (for whom a guest house is ready), botany and forestry students, plant lovers of all categories and the general public.

We need the support and cooperation of other gardens in different countries enjoying especially tropical and sub-tropical climatic conditions.

As the old garden at Calcutta celebrates its bi-centenary under the able leadership of Dr M. P. Nayar, who I am glad to say was once my student, may the "CHAIN OF TROPICAL BOTANIC GARDENS" increase in number steadily and expand in every way so that the *ex-situ* preservation of germplasm and many other valuable contributions to mankind for the future may be achieved.

I shall end this article by quoting the famous Lord Bacon on *Essays of Gardens*

"God Almighty first planted a garden, and indeed it is the purest of human pleasures. It is the greatest refreshment to the spirits of man; without which, buildings, and palaces are but gross handywork."

ROYAL BOTANIC GARDENS, PERADENIYA

D. B. SUMITHRAARACHCHI

Royal Botanic Gardens, Peradeniya, Sri Lanka

The Gardens are situated in the central part of the Island in Peradeniya along the main Colombo–Kandy road about 110 Km (68 miles) from Colombo or about 6.2 Km (4 miles) from Kandy towards Colombo. They can also be reached by train and the nearest railway station, Sarasavi Uyana is situated about 0.8 Km (0.5 miles) from the Botanic Gardens.

The Botanic Gardens at Peradeniya are about 61 ha (147 acres) in extent laid out in an undulating landscape consisting of a horse-shoe shaped peninsula around which flows the longest and the main river in Sri Lanka, the Mahaweli. The mean elevation above sea level is about 484 m (1,550 ft.); the climate is hot, moist and very equable, the mean temperature being about 25°C (76°F). Rainfalls at frequent intervals averaging 2250 mm (90 inches) per year falling on nearly 170 days. January to April is the driest season of the year with cool mornings.

The best time to see a wide variety of plants in bloom at Peradeniya is probably the dry season from February to April when many of the colourful flowering trees of the tropics put on their best blooms.

HISTORY AND FUNCTIONS

The history of the Peradeniya Gardens dates back to the 14th century when King Wickrama Bahu III ascended the throne in 1371 and kept court at Peradeniya. The site became a Royal Garden during the reign of King Kirthi Sri from 1747 to 1780 and from 1780 to 1798, King Rajadhi Rajasinghe resided therein. A Vihara and Dagoba were built at this site by King Wimala Dharma but they were destroyed by the British when they occupied Kandy in 1815.

The first Botanic Garden in Sri Lanka was established by the Dutch but after the English conquest, it was neglected and the land sold by the Government. In 1810, the Colonial Government was advised by Sir Joseph Banks, the President of the Royal Society to open the first English Botanic Garden in Sri Lanka and accordingly, a seven acre garden was established under the name 'Kew' in Slave Island, Colombo with William Kerr as the first Superintendent in 1812. The Garden was moved to Kalutara in 1815 where it was established in an unsuccessful sugar-cane plantation of 600 acres. In the following year Kerr died and he was succeeded by Alexander Moon in 1817 who contributed much to the improvement of the Kalutara Garden. Various reasons particularly the interest taken for the development of the cultivation of coffee led to the removal of the garden to Peradeniya in 1821. Although the decision for the removal of the garden was taken in 1821, the available evidence appear to show that the Botanic Gardens, Peradeniya

were instituted in February, 1822 with Alexander Moon as Superintendent.

The transfer of exotic plants from Kelutara to Peradeniya was made by successive Superintendents at least upto 1843. In addition to his pioneering work on the establishment of the Garden, Moon published his 'Catalogue of the indigenous and Exotic Plants Growing in Ceylon' in the year 1824. The scientific era of the Botanic Gardens began in 1844 with the appointment of George Gardener, a Botanist of established reputation as the Superintendent. He effected many improvements to the Gardens but his chief work was the exploration of the island and the collection and description of her flora. However, he was not destined to complete it for he died in 1849 at the early age of 37. Gardener was succeeded by the famous botanist, G.H.K. Thwaites in 1849 who not only improved the Gardens but also continued the exploration of the flora of the island which found expression in the publication of the first modern flora entitled 'The Enumeratio Plantarum Zeylaniae'. He was also responsible for the establishment of the branch gardens at Hakgala in 1861 and Gampaha in 1876. Thwaites was succeeded by Henry Trimen in 1880 under whose capable management the Gardens were advanced. He established a Museum of Economic Botany and he carried out Thwaites plan of producing a full descriptive flora of Sri Lanka culminating in the publication of the monumental 'Handbook of the Flora of Ceylon' in 1895. Trimen published the first three volumes and the last two volumes were published from Trimen's notes by Sir J.D. Hooker after Trimen's death in 1896. Trimen was succeeded by J.C. Willis as the Director of the Peradeniya Gardens in 1896. He studied problems dealing with the distribution and evolution of species which enabled him to enunciate the 'Age and Area' theory in later years. He also established a laboratory at Peradeniya. While the work at Peradeniya Gardens in the early years was mainly directed to botany and acclimatization of useful plants, activities in later years developed towards agriculture and economic botany which led eventually to the institution of the Department of Agriculture in 1912 after the retirement of Willis in 1911. The Botanic Gardens became a division of the Department of Agriculture with the appointment of H. F. Macmillan as the Superintendent in 1912 and T. H. Parsons as the Curator in 1914. Macmillan improved and extended the Gardens and published the now famous 'A Handbook of Tropical Planting and Gardening' while in service at the Peradeniya Gardens. He retired in 1925 and Parsons continued as the Curator of the Gardens until 1945. He was succeeded by D. M. A. Jayaweera, the first Sri Lankan Superintendent who rendered 30 years of valuable service to this institution and retired in 1971. He improved the medicinal plant collection, the Orchid collection and established a collection of Cacti and Succulents.

In the early years from 1850 to 1890, the Botanic Gardens were actively engaged in the introduction and acclimatization of useful plants. Among other things then introduced may be mentioned tea, rubber, cocoa, cinchona, vanilla, a large number of plants of minor importance, fruits, vegetables, flowers, many shade and timber trees; while the spread in the cultivation of tea and spices like clove and nutmeg has also been largely helped by the introduction of improved varieties.

Activities after 1912 in the Botanic Gardens have been mainly confined to the development of ornamental horticulture in the island. Horticultural work is concerned with the introduction, acclimatization, improvement, propagation, cultivation and distribution of ornamental plants. In 1971, the Botanic Gardens undertook a

research and development programme on the breeding and production of Anthurium and Orchid plants for an export oriented cut flower industry. A large number of suitable hybrids are being developed and distributed to cut flower growers in the island through this project. This demanding task is well rewarded by the appreciation shown by the many visitors to the Gardens, who are especially captivated by the locally produced orchids. The Botanic Gardens are also taking a keen interest in the cultivation of medicinal plants used in indigenous medicine. Nurseries are kept in the Botanic Gardens for the supply of the important and interesting plants to the public and seeds are also sold. Seeds are also exchanged with other botanic gardens and similar institutions abroad. Facilities are also provided to local and foreign botanists to study plants and collect plant specimens. The Botanic Gardens also provide technical know how on the layout of parks and gardens and on flower production. The Gardens also provide training facilities for growers and youth interested in ornamental horticulture.

Peradeniya Gardens is now actively engaged in the revision of the Handbook to the Sri Lankan flora. Other main areas of work include Plant Conservation, Plant tissue Culture and research in Floriculture. Along these lines more than half the number of local Orchids are collected and cultivated along conservation lines. Some rare orchids have been tissue cultured. *Diospyros ebenum* has been saved from extinction whose last surving number was in this gardens. A large number of threatened habitats have been studied and plants collected. Studies are now being conducted on the viability of seeds of local taxa.

PLANT COLLECTION

The main feature of these Gardens is the large number of useful and ornamental plants both indigenous and introduced from all parts of the tropical world. Today, the Gardens contain over 4000 species and cultivars forming one of the valueble collections of plants of the tropical world. These include Flowering tree collection, Spice collection, Palm collection and Palm avenues, Orchid collection, Indoor Plant collection and the Cactus House, Flowering vine collection, Bamboo collection, Conifer collection, Cycad collections, Collection of Fruit Trees, Memorial trees, Flower Garden, Student's Garden, Medicinal Herbs Garden, the Fernery, the Lake, The Arboretum

In addition, the National Herbarium of Sri Lanka is also situated within the Gardens adjoining the Great Lawn. It has a long and an interesting history dating back to 1822 when Alexander Moon was appointed the Superintendent of these Gardens. He laid the foundation for taxonomic investigation of the flora of the island followed by George Gardner and the work of eminent botanists like Thwaites and Trimen. Thwaites started the collection of a numbered series of Ceylon plants (known as C.P.), sets of which were distributed to the principal herbaria in Europe and at the same time retaining a set in the National Herbarium at Peradeniya.

The National Herbarium welcomes foreign botanists who are interested in the Sri Lanka flora but prior approval should be obtained from the Keeper of the Herbarium to view and study herbarium material.

THE NEW YORK BOTANICAL GARDEN

GHILLEAN T. PRANCE

The New York Botanical Garden, Bronx, New York

As The New York Botanical Garden approaches its centennial (in 1991), it is most appropriate that we salute one of our sister institutions, The Indian Botanic Garden on the completion of its bicentenery. Pioneer gardens such as the Indian Botanic Garden served to set the example and the model for the more recent gardens. The growing importance of your garden is reflected in its series of name changes from the Calcutta Botanic Garden to a national name.

Although our garden in New York still bears the name of the city in which it was founded, it is one of the two largest and most active botanical gardens in the United States and maintains a strong national and international program of research, education, horticulture, ecology and plant conservation. We send our congratulations and express our admiration of the active and varied programs of the Indian Botanic Garden, and we look forward to the next hundred years of collaboration between our institutions.

HISTORY

Like many other botanical gardens of the world, The New York Botanical Garden was founded because of the inspiration from another great garden, The Royal Botanic Gardens, Kew and the vision of a young couple. In 1889 a botanist, Nathaniel Lord Britton, from the botany department of Columbia University in New York visited Kew while on his honeymoon with his bryologist wife Elizabeth. They were so inspired by Kew and so aware that the city of New York lacked a major botanical garden that they returned home determined to create a Kew in New York City.

Dr. Britton presented his idea to the Torrey Botanical Club, the oldest botanical club in the U.S. and one that is still based in New York. The idea was appealing to the growing cultural interest of the late nineteenth century as is evident from the fact that by 1891, just two years after the Brittons' trip to Europe, The New York Botanical Garden was incorporated. The city agreed to provide the northern half of the newly formed Bronx Park if funds were raised to support the Garden within a four-year period. The mission of the Garden is stated in its charter as follows:

"For the purpose of establishing and maintaining a botanical garden and museum and arboretum therein and elsewhere within or without the State of New York for the collection and culture of plants, flowers, shrubs and trees, the advancement of botanical science and knowledge and the prosecution of original researches therein and in kindred subjects, for affording instruction in the same, for the prosecution and exhibition of ornamental and decorative horticulture and gardening and

for the entertainment, recreation and instruction of the people"

With the backing of the Torrey Botanical Club and the Department of Botany of Columbia University, Dr. Britton was soon able to raise the quarter of a million dollars required in order for the city to dedicate the land to a botanical garden. Such financial leaders as Andrew Carnegie, J. Pierpont Morgan and Cornelius Vanderbilt II were contributers and members of the first Board of Managers of the new garden.

Bronx Park was formed as the city took over the land of several farms and estates in the Bronx. Much of what is now The New York Botanical Garden was the estate of the Lorillard brothers, Peter and George, who used the flow of the Bronx River to power a wooden gristmill to grind snuff. The Lorillard family mansion was eventually built on the property, but fortunately they maintained much of the area as original forest which explains why today the Garden is in the fortunate position of having the only area of uncut forest in New York City. The snuff mill was closed in the 1870's and the city took ownership of the property in 1884. The Lorillard family moved their business to new Jersey and the residence to Tuxedo Park, New York. The Lorillard mansion was destroyed in a fire in 1923 but other old fieldstone buildings remain from the Lorillard era such as what is now the snuff mill restaurant (a historic land-

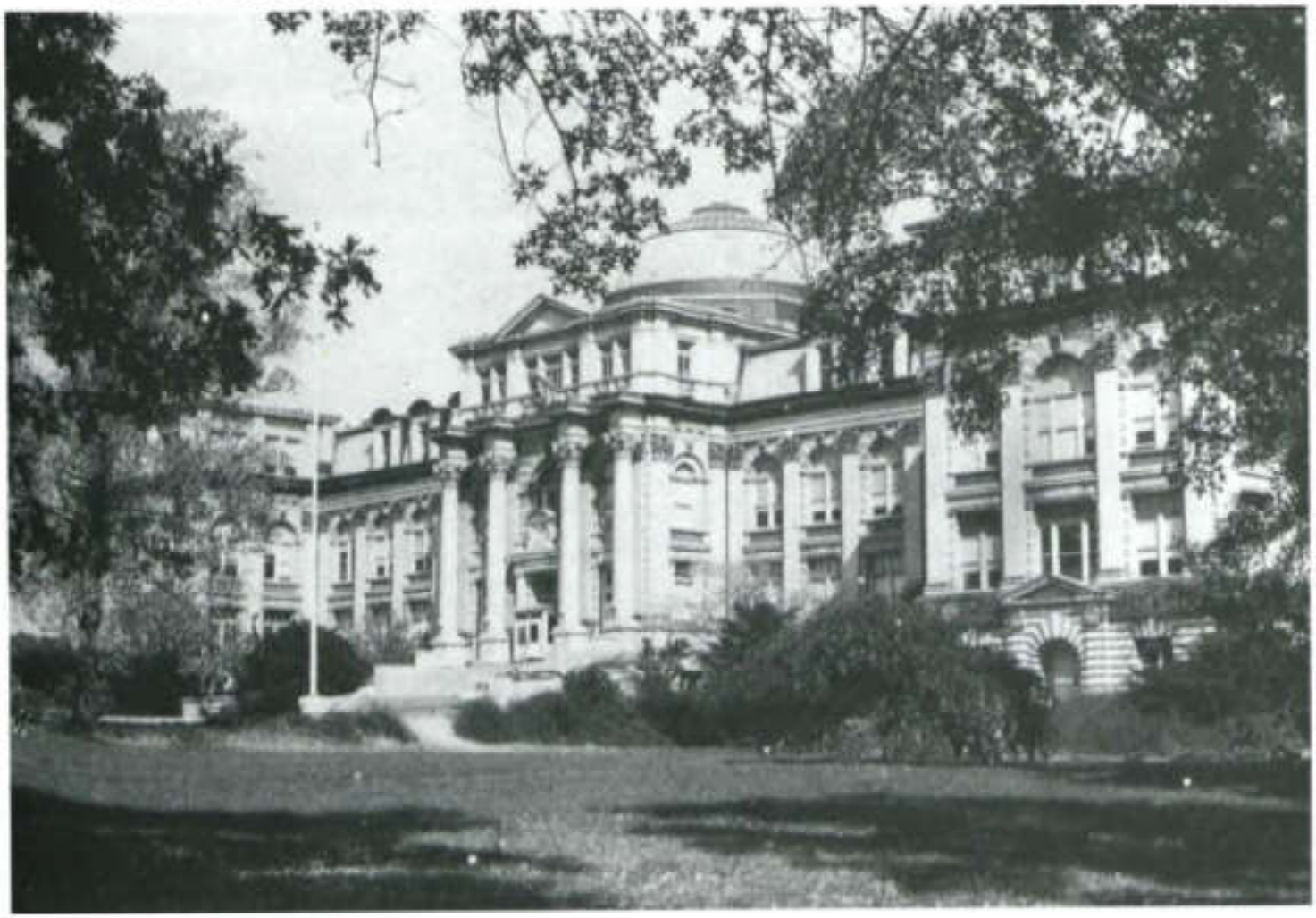
The Lorillard snuff mill building, a historic landmark which now houses a restaurant and visitor accommodation.

mark building, Fig. 1), a small gatehouse that is now a private residence and the former stables that house part of the maintenance staff of the garden.

Once the land was secured and start up funding was raised, Dr. Britton lost no time in organizing construction of the buildings, landscaping, the collection of living plants and the establishing of scientific and educational programs. The large museum building (Fig. 2), which now houses the herbarium, the shop and many offices was constructed in 1901 to be followed shortly by the largest glass conservatory in the new world completed in 1902. The affiliation with Columbia University brought with it a group of botanical scientists and eventually collections such as the herbarium of John Torrey, Columbia College and the Columbia College of Pharmacy which formed a base for the fast growing herbarium and the botanical portion of the library of Columbia College which formed the nucleus of the library. Britton maintained an active research career and specialized in the Caribbean flora, hence the first of the numerous scientific expeditions of the garden was to Puerto Rico in 1898, sponsored by Cornelius Vanderbilt II.

Nathaniel Lord Britton remained as director of the Garden until 1929. During 38 years from the founding of the Garden until his retirement Britton fulfilled his dream and left a botanical garden with one of the largest botanical museum in

The museum building of the New York Botanical Garden which was constructed in 1901. *Photo Credit* : Allen Rokach



the world, the largest herbarium in the United States, the largest greenhouse, and the best botanical library in the Americas. With that tradition, the Garden has built on its strength in the intervening years.

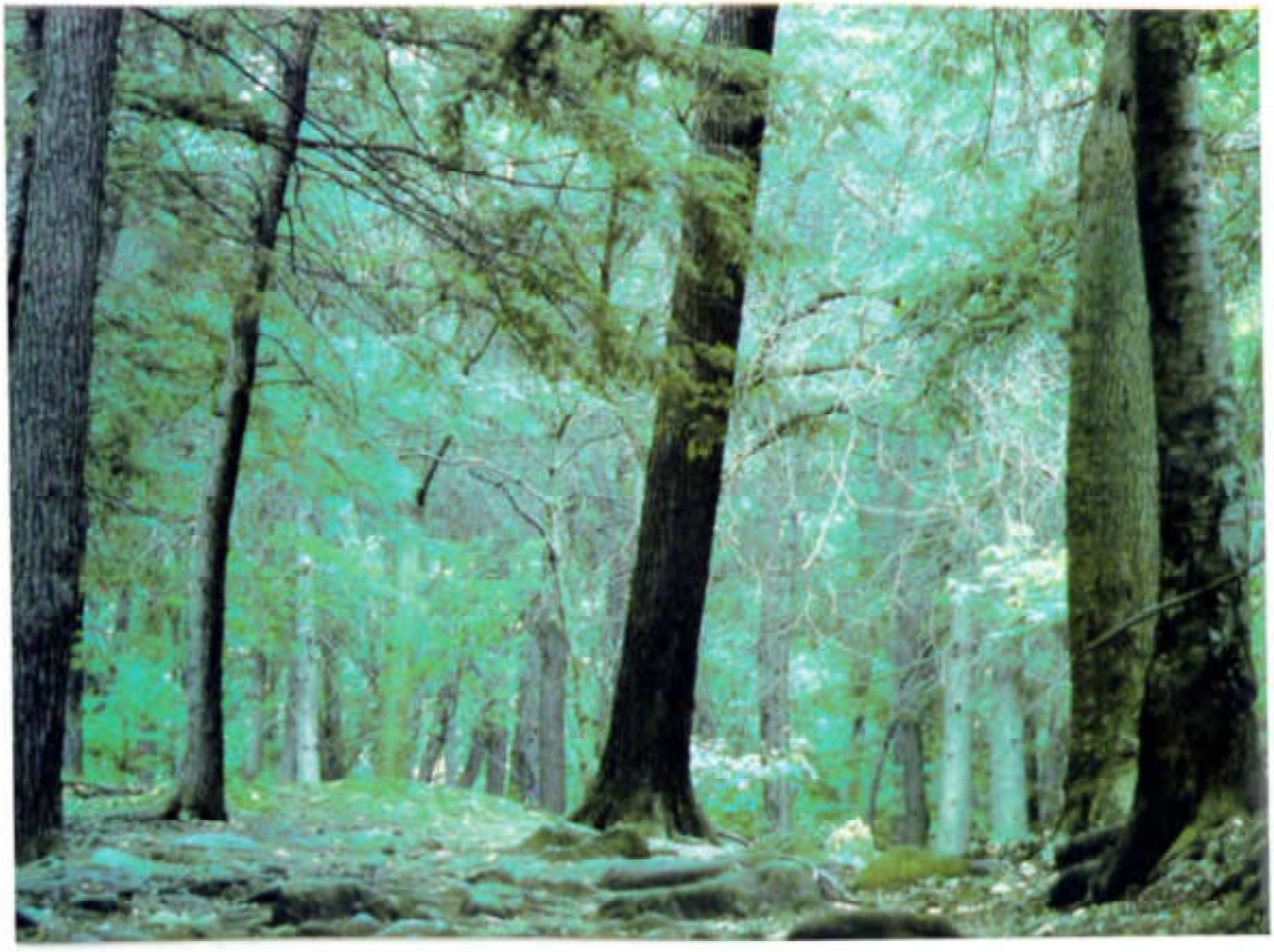
The way in which the Garden was set up was as a private not-for-profit corporation chartered in New York State. The City of New York owns the buildings and grounds and consequently provides most of the funds for their operation which currently constitute about 30 percent of the total budget. The rest of the operation is supported by a small endowment, individual, foundation and corporate gifts and by the State of New York Natural Heritage Trust. The scientific program receives support from many different grant sources such as the National Science Foundation and the U.S. Agency for International Development.

Over the years the exact delimitation of the Garden's boundaries has changed as the Bronx River Parkway was built in the 1920's, taking away the eastern portion or as a small area containing two lakes was added in the 1970's. Today the Garden is 250 acres in area and is bordered to the south by the Bronx Zoo of approximately the same size, to the north by another area of forest, and to the west by the campus of Fordham University.

THE GARDEN AND HORTICULTURE

The landscaping of the grounds and the construction of special horticultural exhibits

View of the New York Botanical Garden forest. *Photo Credit* : Allen Rokach



has been a priority from the inception of the Garden. Efforts were made both to develop exhibition gardens and to conserve and enhance the beauty of the natural forest already on the grounds. One of the strengths of the Garden is its combination of natural beauty and formal gardens.

The forest (Fig. 3) is a forty-acre tract of land surrounding the deep gorge of the Bornx River. On a walk through the forest one is amongst tulip trees *(Liriodendron tulipifera),* hemlock *(Tsuga canadensis),* white ash *(Fraxinus americana)* and red oaks *(Quercus rubra)* and many other native species (Fig. 3). However, over the years excess uncontrolled visitation and the invasion of exotic species such as the cork tree *(Phellodendron)* has altered the forest considerably. Currently an ecological management and use plan is being developed by a team of researchers from the

The Enid A. Haupt Conservatory, built in 1903. *Photo Credit* : Allen Rokach

The desert house of the conservatory showing the dome of the palm house in the background
Photo Credit Allen Rokach

Garden's ecological department, the Institute of Ecosystems Studies. This project is combining the production of a sustainable management plan with a research program on one of the most interesting tracts of urban forest in the United States.

For me the two gems of the formal horticulture program are the Enid A.Haupt Conservatory and the Thompson Rock Garden. The conservatory (Fig. 4) was built between 1900 and 1902 and is a magnificent example of a victorian style greenhouse with over seventeen thousand panes of glass set into a wrought iron framework. It is dominated by a central dome which rises to 90 feet and houses the palm collection where a third of the genera of palms in the world may be seen. To either side of the dome set in a rectangle are the ten other houses each with a different purpose and showing different climate zones of the world. In the central area, surrounded by the glasshouse, are two outdoor ponds used each summer to display water lilies and other aquatic plants. Four of the houses are used for changing exhibits for the seasonal flower shows that are well known events in the New

The Thompson Rock Garden. *Photo Credit* : Allen Rokach

York area. For example, recent autumn shows of Japanese chrysanthemums have drawn large crowds, as does the annual orchid show in collaboration with the New York Orchid Society. One house is called 'The Greenworld for Children' and houses an educational exhibition of economic plants called 'The Greenworld Grocery Store' where city children can see both the plants and the products which previously they thought to come only from the supermarket. The basement of this house contains classrooms where much of the children's education program takes place. The other houses vary from the tropical rainforest habitat to the American desert house (Fig. 5) where one can see a giant saguaro cactus. This species was named *Carnegiea gigantea* by Britton in honor of Andrew Carnegie, one of the founders of the Garden. In botanical collection terms the two desert houses and the fern house are most outstanding. The fern gallery contains a large collection of ferns which has been built up by collaboration between the horticulture department and the fern taxonomists of the Science department. There is also an outstanding collection of hardy ferns in the native plant garden on the grounds and in the fern glen at the Mary Flagler Cary Arboretum.

The conservatory was completely restored between 1975 and 1978 through the generosity of Mrs. Enid A. Haupt and was named in her honor in 1979. It is a wonderful combination of seasonal displays, the plants of the world and educational exhibits.

The Thompson Rock Garden (Fig. 6) is neatly placed in a natural rock outcrop at the edge of the forest. It is quite remarkable considering the difficulties of growing rock garden plants in the extremes of the New York climate, especially through the long hot summers. It was constructed in 1934 under the direction and design of Thomas H. Everett who was director of horticulture at the Garden for many years and is another important and colorful person in the history of the institution. Many different habitats have been created in the rock garden amongst the large boulders, the stream that flows through the center and the large trees that remain. There is a rock scree full of fascinating plants from that habitat and an outstanding collection of heathers.

There are many other important horticultural exhibits and collections on the Garden's grounds. Adjacent to the rock garden is a native plant garden integrated into the forest. A fine collection of native plants can be seen by regular walks through this garden over the year. It has such areas as a limestone outcrop and a sandy area of pine barren vegetation. Nearby is an extensive meadow planted with many wildflowers. In the fall the meadow (Fig. 7) is a spectacular site with its large number of native meadow species in full bloom.

The Montgomery conifer collection brings to the public the beauties of the cone-bearing plants. This four-acre area contains over 200 trees, some there for their botanical interest, others to show unusual dwarf or weeping forms of certain conifers. There are collections of lilacs, azaleas, magnolias, cherries and several other plant groups carefully placed in appropriate parts of the landscape. There is also a rose garden, the Victor Memorial Garden with nice trellis work, and the Jane Watson Irwin Perennial Garden near to the conservatory (Fig. 8).

The horticulture department is constantly striving to create new exhibits to show both the beauty and diversity of plants and inform the public about plants. Currently many new projects are underway including a series of demonstration gardens

to provide ideas to local gardeners, the restoration of the original rose garden designed by Beatrice Farrand, and the installation of a compass garden.

EDUCATION

Education is a major part of the Garden's Programme and ranges from classes for young children to a Ph.D in botanical science. The school programs serve about 50 thousand children each year who visit the Garden as part of their school experience to take short courses or one day programmes. The children's garden which provides garden space and a programme of training for local children, was re-opened in 1986 on the site of the Lorillard mansion. Here, children from throughout the metropolitan area environment learn how to grow plants and then enjoy their harvest of flowers, fruit and vegetables. The Garden's adult education program offers over 500 courses annually (Fig. 9). Courses range from practical gardening to molecular biology. The programme is the largest of its kind in a cultural institution in the U.S. and many of the courses are registered with the state of New York for undergraduate college or equivalency credit. An undergraduate course in plant science is offered jointly with Herbert H. Lehman College of the City University of New York. The scientific program also has a link to the same college for a Ph.D program in botany.

The meadow which forms part of the native plant garden. *Photo Credit* : Allen Rokach

The graduate courses are taught by Garden staff and professors from Lehman College and over the years many students have been trained in plant taxonomy, ecology, economic botany and related areas. The current graduate program with Lehman College began in 1971 and replaced a similar arrangement with Columbia University which functioned from the inception of the Garden until that date. The Garden also runs The School of Horticulture, a 21 month state licensed vocational training program for professional horticulturalists in the U.S. The education department also sponsors many public lectures, symposia and other public functions. One series of symposia, accredited by the American Medical Association is conducted for physicians as one of their continuing education credit programmes required for the maintenance of their physicians state licenses. The education program also offers courses off campus in several other sites in the New York area and organizes study tours to many parts of the world.

SCIENCE

Since its foundation with a close affiliation to the Department of Botany of Columbia University, the Garden has had an extremely active scientific programme which has concentrated on plant taxonomy. The active tropical field program began with an expedition in 1898 to Puerto Rico sponsored by Cornelius Vanderbilt II. Since that time some 550 expeditions have

The Jane Watson Irwin perennial garden at the New York Botanical Garden.

helped the Garden to build up one of the largest herbaria in the United States (Fig. 10), which exceeded five million specimens in 1985. Although worldwide in scope, the herbarium specializes in the plants of the Americas and is particularly rich in the plants of North America, the Caribbean, Venezuela, the Guianas and Brazil. Through the acquisition of several collections the herbarium is rich in historic types, many of which were collected long before the institution was founded. For example, it houses a set of Richard Spruce's Amazon collection which was obtained from Cambridge University in England. The type collection of 125,000 numbers was photographed and distributed in microfiche form, together with a complete catalog, in 1985. Today the herbarium operates one of the most active exchange and loan programs in the world with over 55,000 specimens being sent out on loan last year (see Table 1).

The herbarium collection covers the entire plant kingdom and the fungi and in addition to phanerogams it is particularly strong in fungi, bryophytes and ferns. The taxonomic staff includes specialists in each of those groups. Bryology was given a

The continuing education program offers a large number of courses to adults for pleasure or for academic credit.

good start by Elizabeth Britton, the wife of the first director, who was able to obtain several important collections from Europe including the Mitten herbarium with its many types. The palaeobotanical collection which originated from Columbia University was sent on permanent loan to the Peabody Museum of Yale University in 1983.

The herbarium currently occupies most of the original museum building, and other functions such as the library and administration are housed in newer wings adjacent to that building. The museum building is an old one with high ceilings in which it is difficult to control the environment and where much space is lost. The herbarium is crowded and reaching the maximum capacity it can in the present building. Accordingly one of the main goals of the 1991 centennial is to build a new modern and environmentally controlled building to house the herbarium and library. A design has been produced by the well-known architect Philip Johnson and it is planned to start building in early 1988. The transfer of the herbarium to the new building will provide the much needed space for a botanical museum area and additional offices and laboratory space.

The herbarium of the New York Botanical Garden which is housed in the museum building.

The scientific staff today continue a programme of research and exploration in North and South America. During its history, the Garden has produced many books and floras on the plants of North America. Currently its main project in the U.S. is the 'Intermountain Flora' of the region between the Rocky Mountains and the Sierra Nevada. Three of the six volumes of this flora have been published under the authorship of three Garden botanists, Arthur Cronquist, Noel Holmgren and Patricia Holmgren together with two other outside collaborators.

Active research programs in the tropics include work on a 'moss flora of the Caribbean by William R. Buck and William C. Steere; work on the flora of the Guayana Highland of Venezuela and the Guianas led for many years by Bassett Maguire who still continues his work and more recently continued by Brian M. Boom, participation in the Flora of the Guianas project by Scott A. Mori who also runs a field project in French Guiana and Atlantic Coastal Brazil; the exploration of Amazonian Brazil by Ghillean T. Prance which includes participation in Projeto Flora amazônica programme of Brazil, studies of Andean plants and monographic studies of the Lecythidaceae by James L. Luteyn; the fern floras of Oaxaca, Mexico and Hispaniola by John T. Mickel and Joe Beitel and a comparative programme of studies in tropical Asia directed by Tetsuo M. Koyama who works on the taxonomy of the Cyperaceae and Liliaceae.

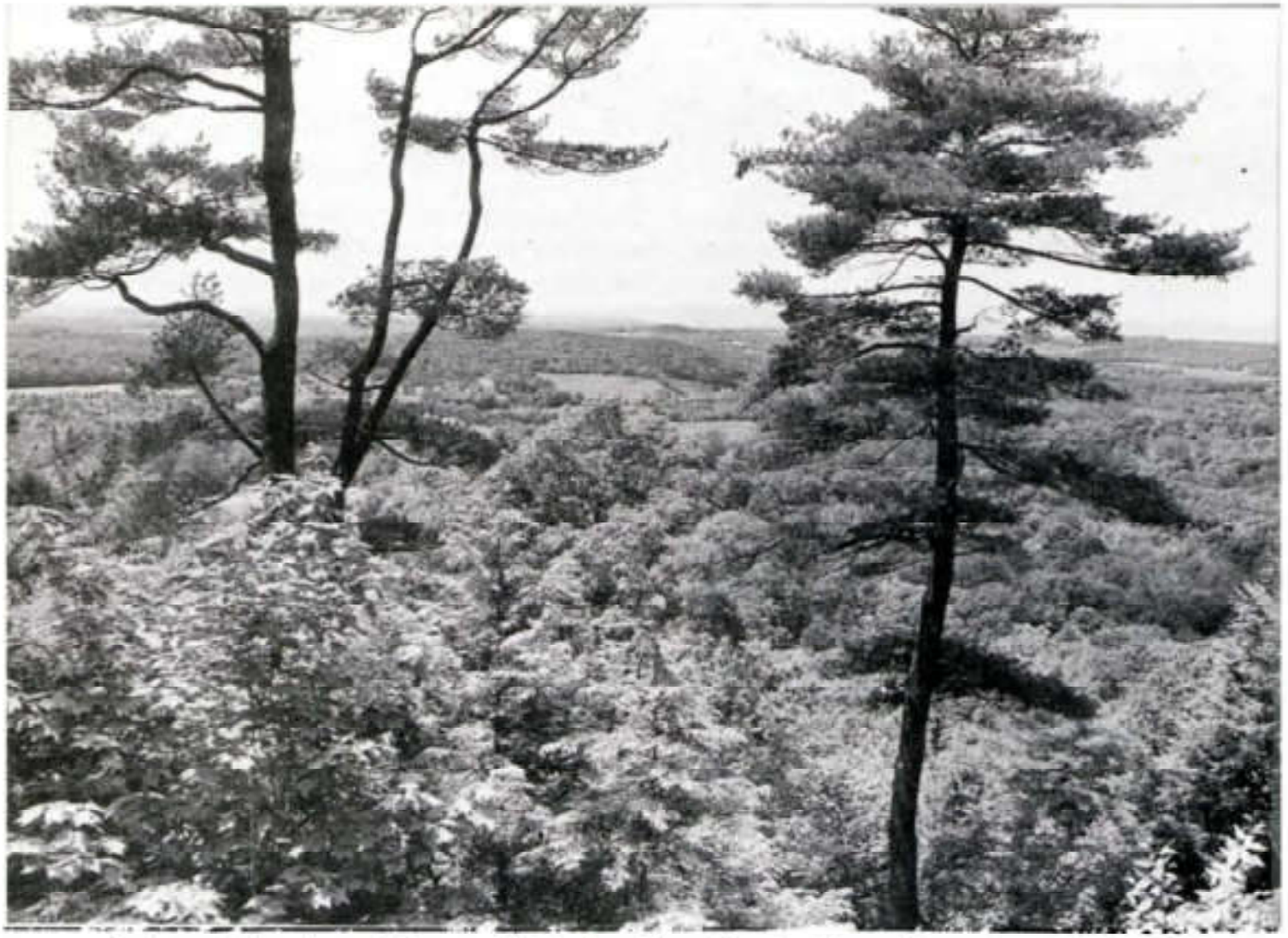
Today this group of systematists is involved in many field based studies of quantitative forest inventory, pollination biology, ecology and studies of other plant-animal interactions. The systematics section also includes an anatomy, cytology and morphology lab equipped with a modern scanning electron microscope and the Harding Chemistry Laboratory where a small program of chemical taxonomy is maintained. This laboratory also houses the fungal culture work, tissue culture facilities and labs for the forest ecology project on the grounds of the Garden.

Work in science and all sections of the Garden is enhanced by the presence of the largest botanical and horticultural library under one roof in the Western Hemisphere. The library includes almost one million accessioned items of books, journals, botanical art, ancient herbals, seed catalogs and original manuscripts and archives. Its strength in plant taxonomy, ranging from pre-Linnean material to the latest books makes the Garden an excellent center for taxonomic work. It is seldom that staff scientists need to borrow books from elsewhere when searching for the protologues of any genus or species. The library is open to the public and also provides extensive service to businesses and private citizens of the New York area. The library enters all cataloging records into the On-Line Computer Library Center Inc. (OCLC) data base. This provides access to the Garden's library collections by over 6000 research, academic and public libraries in North America and Europe.

THE INSTITUTE OF ECONOMIC BOTANY (IEB)

In 1981, as the result of an international planning conference, shortly after the arrival of the current president, Dr. James M. Hester, the Garden decided to formalize its applied work into three institutes, Economic Botany, Ecosystems Studies and Urban Horticulture. The first two are in full function and the third is in the early stages of development.

The Institute of Economic Botany was created in 1981 "In recognition of the ongoing loss of potentially useful plant species that could play a role in resolving some of today's most pressing human



A view of the top of Canoe Hill in the Mary Flagler Cary Arboretum, the headquarters of the New York Botanical Institute of Ecosystems Studies

concerns" It is dedicated to the discovery and development of new and underexploited food and fuel plants. With a generous start-up grant from the Andrew W. Mellon Foundation, the IEB now employs a full-time staff of six scientists and three graduate students.

The IEB is taking two approaches to fulfill its mandate 1) The study of the ethnobotany of indigenous peoples, and 2) The detailed study of selected plant species of particular promise from the tropics.

The ethnobotanical studies have focussed on quantitative studies of the extent to which Amazon Indians use the rainforest. The study will be completed by the end of 1987 when 6 different tribes will have been analyzed in detail. The results are proving spectacular in terms of both uses and forest conservation. For example, the Ka'apor Indians of Brazil studied by William Balee continues studies of three different tribes and Brian M. Boom has completed studies of the Chácobo Indians of Bolívia and the Panare Indians of Venezuela. Ethnobotanical work is also underway in Ecuador where staff member Marc Baker is training the Shur Indians and setting up a Shuar herbarium for that nation.

Detailed ecological studies, germ plasm collection and establishment experiments of selected crops were begun with a study of the babassu palm *(Orbignya phalerata,* by Michael J. Balick. This multipur pose palm, a source of oil, charcoal, starch and other products grows in large natural stands in the transition zone

between Amazonia and the cerrado region of central Brazil. Drs. Christine Padoch and Charles M. Peters study selected fruits of Amazonian Peru, including the Camucamu, *Myrciaria dubia* which contains 20-30 times more vitamin C than citrus. Also in Peru, Jan Salick studies the domestication of the Cocona *(Solanum sessiliflorum)*.

The projects of the graduate students of IEB include a study of high Andean tuber crops, the guaraná *(Paullinia cupana)* plant of Brazil and the *Euterpe* palm. The Asiatic program of the Garden maintains a strong program in economic botany and includes a study of the starch yielding species of *Canna* and of the chinese chestnut. Several of the taxonomists are involved in economic botany projects such as studies of the Brazil nut (Lecythidaceae) by Scott Mori and Ghillean Prance and of the cashew nut *(Anacardium)* by John Mitchell. This gives the Garden a strong and active program in the field of economic botany and an important role in the training of economic botanists and ethnobotanists through courses taught both in New York and Yale University in the U.S. and in several places in South America.

THE MARY FLAGLER CARY ARBORETUM AND THE INSTITUTE OF ECOSYSTEM STUDIES

In 1971 the Garden was given the task of establishing an Arboretum on the 2,000 acre former Cary estate (Fig. 11) in Millbrook, New York, about 70 miles north of the Garden in the Bronx. The Arboretum was established as a focus for environmental work of the Garden and immediately established a scientific programme that is deeply involved in local environmental issues such as the establishment of sustainable vegetation along power line right-of-ways and the control of white tailed deer in the region, and in overseas issues such as environmental impact statements for several south American hydroelectric projects.

In 1982 the research program at the Cary Arboretum was restructured as the 'Institute of Ecosystems Studies' headed by the distinguished ecologist Dr. Gene E. Likens. This Institute is concentrating its efforts on the issues of disturbance and recovery of northern temperate ecosystems. The Institute now consists of a group of 12 ecologists working on such areas as nutrient cycling, stream ecology, chemical ecology, plant-animal interactions and wildlife management. The basic ecological research on ecosystems leads the Institute into many practical areas of ecology such as the lead it is giving on studies of the effect of acid rain and acid cloud on the vegetation of the northeastern United States (Fig. 12). The Arboretum, with its two thousand acres of forest, wetlands, old fields and streams, is an ideal location for ecological research. It also maintains several public display areas such as a fern glen with a fine collection of hardy outdoor ferns and a newly constructed perennial garden. Education is also an important part of the program of the Institute of Ecosystems studies and courses vary from school programs to the education of undergraduates and graduates from several universities. Facilities for accomodation of students makes it an ideal place for extended and detailed studies.

PUBLICATIONS

Almost since its beginning the Garden has been an active publisher of scientific and popular botanical literature. The membership receives *Garden* a magazine with general articles illustrated in color about all aspects of horticulture, conservation and plant science. It is published by

the Garden for the Garden Society, a consortium of gardens and arboreta, for distribution to their members. *Garden* replaced *Garden Journal* which was an exclusively in-house journal with the same general aims as Garden.

The scientific publications department publishes 7 journals, four of which are published on a regular basis and 3 as material is available (See Table 2 for a list of present and past journals). *Brittonia*, a quarterly journal of systematic botany, is one of the main outlets for work by the scientific staff but with about fifty percent by outside authors; *Botanical Review*, also quarterly, is for review articles on all aspects of botany; *Mycologia* is a bimonthly journal published for the Mycological Society of America; *Economic Botany* is published quarterly for the Society of Economic Botany. The journals which are published at irregular intervals are the *Memoirs of the New York Botanical Garden*, for lengthy works mainly of staff and students and associated scientists, *Contributions of the New York Botanical Garden*, a reprint or translation journal; and *Advances in Economic Botany*, the journal of the Institute of Economic Botany.

In addition to its serial publications, the Garden has for many years published a selection of scientific and popular books and symposium proceedings. Such popular works include 'The Wildflowers of the United States' originally published for the Garden by McGraw Hill, and two orchid books by Carlyle Luer. Symposium proceedings include 'Extinction is Forever' a 1976 conservation symposium and 'Advances in Cladistics', the proceeding of a meeting of the Willi Hennig Society. The publication programme is backed by extensive marketing and advertising activity including exhibits at important meetings and congresses. The Garden regards the dissemination of published botanical information as an important part of its mission.

MISCELLANEOUS PROGRAMS

The Garden is dependent on its fund raising efforts to support its programs and therefore maintains two gift shops which help to provide income. One is located at the Garden in the Museum Building and the other in Manhattan in the IBM building which is centrally located in New York City.

The programs are backed by a large range of administrative and computer services although so far no central computer system is installed. Departments use a range of IBM and CPT computers for administration, finances, word processing and scientific research. The scientists also have access through terminals to the mainframe computer of the City University of New York and the library has a computer link to the main library data bases. The computerization of the library and catalog to an on-line system is nearing completion.

CONSERVATION

Through the varied programs, Garden staff members have become increasingly involved in the issues of environmental conservation as the problems have increased over the last few decades. The establishment of an Institute of Ecosystems Studies obviously forms a basis for our current work on environment issues, but many other parts of the Garden are environmentally involved. For example, many of the tropical systematists are involved in the problems of tropical rainforest destruction and a major reason for the establishment of the Institute of Economic Botany was to work towards creation of sustainable yield systems in the tropics. The Garden following the norms of 'The World Conservation Strategy' (IUCN, WWF

UNEP, 1980), is involved in issues both of land utilization and of direct conservation. Several of our scientists have contributed data and been involved with the establishment of reserves and national parks in South America, and many data from floras and monographs prepared by our staff are being used in plant conservation activities. Another way in which our Garden promotes interest in conservation is in its educational program through courses and symposia on conservation issues. For example its American bicentennial symposium in 1976 entitled 'Extinction is Forever' resulted in a volume (Prance & Elias, 1977) which has been widely used by the conservation community. The horticultural department of our Garden is collaborating with the Center for Plant Conservation on the conservation of living plants on the grounds of the Garden. The existence of an area of natural forest and a large native plant garden and meadow make the Garden an excellent place to conserve at least a few rare and endangered species.

CONCLUSION

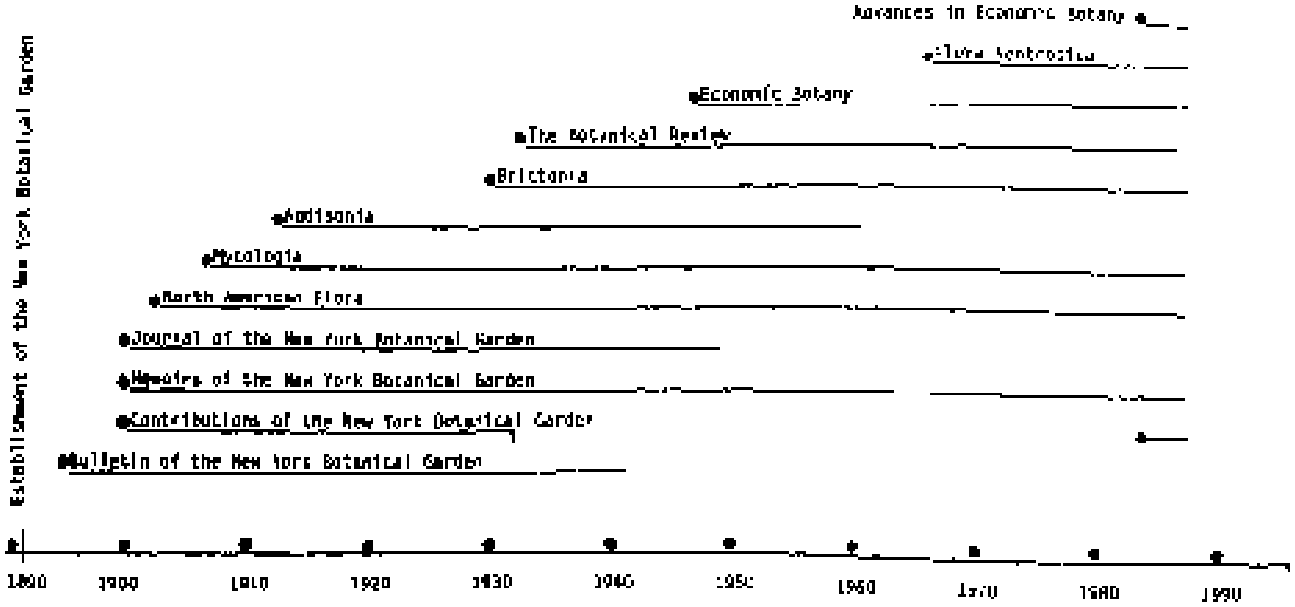
As with most major botanic gardens such as the Indian Botanic Garden, The New York Botanical Garden is a complex and dynamic mixture of horticulture, science, education and conservation that gives the botanic gardens of the world a unique cultural rôle. As we near our centenary plans for the new herbarium building, the preparation of a history of the founding and early years of the Garden is being written by Dr. Frans Stafleu of Utrecht, Holland, and the organization of the centennial symposium are some of the things that preoccupy us. Our goal is to continue our involvement in botanical inventory of the Americas and the interpretations of botany through horticulture and education and to put considerable effort into conservation issues both at home and in the tropical rainforest regions of the world. The current phase of tropical deforestation has given a new urgency to the work we do in both inventory and the search for more sustainable use-systems through our Institute of Economic Botany.

Pollution chamber at the Institute of Ecosystems studies. *Photo Credit* : Allen Rokach

TABLE 1 : ACTIVITY OF THE NEW YORK BOTANICAL GARDEN HERBARIUM : NUMBER SPECIMENS JULY 1, 1984-JUNE 30, 1985

	Vascular plants	Non-vascular plants	Total specimens June 30, 1985	Average/year for past five years
Outgoing loans	47,740	7,532	55,272	49,564
Incoming loans	17,494	4,709	22,203	25,051
Outgoing exchange	41,857	6,706	48,563	41,606
Incoming exchange	47,166	7,351	54,517	70,466
Total outgoing specimens	110,615	15,241	125,856	108,971
Total incoming specimens	93,569	26,598	117,161	136,392
New genus covers	8,020	3,512	11,532	9,142
Repairs	10,376	8,133	18,509	15,151
Newly mounted specimens	65,840	19,968	85,808	80,212
Specimens filed	88,743	36,006	124,749	121,215

TABLE 2 : SCIENTIFIC PUBLICATIONS OF THE NEW YORK BOTANICAL GARDEN CHRONOLOGY



The recent creation of that institute together with an institute of ecosystems study has given a new vision and urgency to our mission. We hope that we will during our second century be one of the institutions that contributes to the future welfare of humankind.

ACKNOWLEDGEMENTS

The photographs unless stated otherwise are by Allen Rokach. I thank P. Holmgren, S. Mori, J. Reed and C. Totemeier for reading an earlier draft of this manuscript.

REFERENCES : Prance, G. T. and T. ELIAS (eds.) Extinction is forever. The New York Botanical Garden, NY 1977

IUCN, WWF, UNEP. The world conservation Strategy. Gland, Switzerland

THE CORDOBA BOTANICAL GARDEN (ANDALUSIA — SPAIN)

J. E. HERNANDEZ BERMEJO AND DRA. M. CLEMENTE MUNOZ
Jardin Botanico de Cordoba, Spain

DESCRIPTION AND ORGANIZATION

The Botanical Garden has an area of 5.5 hectares and is located on the banks of the Guadalquivir River by the Fortress of the Catholic Kings, the Mosque and the San Raphael Bridge. The Botanical Garden has an: Arboretum, Botanical School, Agricultural Plants School, Rose Garden, Rock Garden, Ecological Groups, Tropical and Sub tropical Plants Greenhouse, Garden for the Blind, Paleobotanical Museum and Nursery. There is an office building where the Library, Germplasm Bank, Conference Room, Herbarium, Laboratory, etc. are located.

The foundation is presided by the His Majesty King Juan Carlos I. It has a General Board (Mayor and Councilmen), an Executive Board (representatives from the City Council and the University) and a Direction and Technical Scientific Committee (professors from the University of Córdoba working for the Garden as an extension of their services). There's also an Administration, gardening workers (17), University students (who work for the Garden without payment), scholarships and graduate collaborators.

The Botanical Garden was founded in 1980 and it is expected to be opened on 1987. The main objectives of the Botanical Garden are:

— The protection and exposition of the autochthonous flora in danger of extinction as the Botanical Garden is located in a region and country of enormous floristic richness with a high concentration of endemic species. In fact, out of the 1600 Iberian endemic species, approximately 1000 are located in Andalusia, the fourth part of them being exclusive of this region.

— Conservation of collection of species and varieties representative of andalusian agriculture as well as of tropical and sub tropical species with economic interest and which will be of interest to the visitors and botanists.

ACTIVITIES AND FUNCTIONS

Apart from the design and organization of the Botanical Garden, we will now give a detailed description of the specific functions the Garden has been carrying out simultaneously towards its construction.

1 Specialization of Index Seminum

Since 1982, four **Index Seminum** have been published. This has made it possible to distribute almost 12200 sample specimens to most of the Botanical Gardens in the World. The recollections are carried out preferably in Andalusia and in all cases in the southern and Mediterranean Iberian regions with greater botanical interest. With this specialization we hope to contribute to the spread and conservation of the Spanish autochthonous species as the Córdoba Botanical Garden is the only Botanical Garden in Andalusia.

Numerous taxa from Sierra Nevada, Sierra Morena, Cazorla, Grazalema and the Cadiz — Huelva — Algarve coastline have been offered and distributed together with others from the Balearic Islands, Central Mountain Range and other Iberian areas in these last four years.

2. **The Plant Germplasm Bank specialized in Iberian Balearic Flora in danger of extinction.**

The collection of seeds with a high biological value either directly from Nature or from their propagation in the Botanical Garden can not only be centered on their exchange through the **Index Semina** but also through introductions of live collections in the Garden. Large part of the efforts necessary to complete the conservation program would be wasted if it were not for the development and maintenance of a Germplasm Bank. For this purpose, several hundred species from the most Iberian estenochoric areas are beginning to be conserved in cold and low humidity. The objective of this Bank is to specialize it in the conservation of Andalusian endemisms.

Independantly of the existence of Germplasm Bank with a more international character or wider objectives, the responsibility of the Botanical Garden within Andalusia is to maintain a Germplasm Bank specialized in the protection of its own genetic resources. It has a triple function: a) long-term conservation,

Aquilegia cazorlensis Heywood

b) allow for an exchange under justifiable demands, c) enlarge collections of live plants exposed in the Garden.

3. **Multiplication programs of species in danger of extinction, Re-introduction to their natural habitats.**

As a result of the handling of the Germplasm Bank and facilities for the multiplication of plant species, we have been working on the conservation of populations of some species in danger of extinction. We have been successful with some Balearic species like: *Silene hifacensis* and *Naufraga balearica* and with some Andalusian species like *Aquilegia cazorlensis* and *Antirrhinum charidemi*. Recently some collaboration agreements with the General Research Board and Agriculture Extension Service (from the Agricultural Department of the Andalusian Autonomous Government) were signed for the development of a research project aimed at the multiplication of *Betic orophilous* plant species with a high biological interest. Not only populations living widely in the Botanical Garden but also others to be reintroduced to their habitats have been obtained.

Antirrhinum charidemi Lange

4. Promotion of High Altitude Gardens and associates.

Aware of the imposibility to conserve in an optimal way many of the plant communities and species from the Andalusian mountains, the creation of associated gardens in the areas with greater natural value within Andalusia has been promoted. Currently, from different initiatives started, we can point out the agreement signed with the Autonomous Government and the technical project elaborated for the construction of a Conservatory and High Altitude Garden in the Lanjaron Valley at the foot of the Cerro del Caballo (Sierra Nevada).

In the area chosen, there are many of the most significant Nevada endemics. It is situated at 2,700 metres and it will have an area of 2.5 ha. The construction together with the biological research project were begun this year.

We feel that this is one of the most important models to integrate the Botanical Garden in the community. It is an effective way to make other city halls and organizations participate in the functions of the Botanical Garden, and at the same time it itself finds a necessary help in the protection of nature and becomes a cultural extension.

5. Teaching and public Impact.

Perhaps one of the most gratifing experiences of our short history has been our response to a teaching and public

The central Plaza with the exposition greenhouse in the background

impact demand. We have been asked and collaborated in conferences, round tables and radio programs. We have had on the air for a year a program of botanical impact aimed at school children. An audiovisual program explaining our work and objectives has been prepared for the neighbourhood associations in Córdoba. A video with similar objective is currently being filmed although the Botanical Garden has not been opened yet, many schools have already visited it. These visits have been made up of small groups with a guide giving them an extensive cultural background of the Garden.

Different departments from the University of Córdoba do their fieldwork and practices in the Garden. Besides the group activities, we can point out the presence of 22 intern students from the University currently working at the Botanical Garden. The nature of these collaborations and practices does not only belong to the Botanical Garden since the University and the region have an agronomical tradition. The School of Agronomical Engineers uses the facilities of the Botanical Garden (watering system, greenhouses powered by solar energy, construction techniques for buildings in rural areas, etc.) in their

Exposition Greenhouse : Partial view of the central module

Rose Garden : partial viéw

lesson, some of these facilities like the solar systems for the exposition greenhouse are in themselves quite interesting to the visitor.

6. Environmental educational programs

The Cordoba Botanical Garden has recently signed a collaboration agreement with the Environmental Department in order to develop an environmental educational program which will have :

a) Courses on natural resources in Andalusia and on their protection directed to secondary school teachers.
b) Programmed visits dealing with the environment to the Garden for 2,500 visitors.
c) Production of audiovisual aids and publications on the environment and plant natural resources.

7. Landscape assessment and restoration

The Córdoba Botanical Garden has been asked to assess several projects for the construction of new public parks. However, its participation in the restoration of some old historical garden has been much more significant. The most ambitious and creative of the collaborations asked for has been asked by the cultural delegation in Cordoba from the Autonomous Government for the restoration of the gardens of the historical site of Medina-al-Zahara, a city built by Abd-al-Rahman III in the X century and which is currently underway.

The site is located 10 Km. from Córdoba, on the foot of the Sierra Morena and it is one of the most important archeological remains in Europe, only comparable to the Alhambra in Granada and the Mosque

in Córdoba. The restoration project implies bibliographical and botanical documentation which we have been working on for months.

8. Museum and Paleobotanical Unit

With the collaboration of Prof. R. Wagner, (*Dr. Honoris Causa*) by the University of Córdoba, the Botanical Garden conserves thanks to the work and donation of this researcher, a collection of over one hundred thousand fossils of **Carbonifera** flora (especially Iberian **Carbonífero** and in many cases from Córdoba). With part of this material the museum was built carrying out lines of work which encourage Plant Paleobotanical studies in Andalusia.

Arboretum

CRUICKSHANK BOTANIC GARDEN : UNIVERSITY OF ABERDEEN

C. C. WILCOCK

Cruickshank Botanic Garden University of Aberdeen, Aberdeen

FOUNDATION

Under the terms of a benefaction made to the University in 1898 by Miss Anne Cruickshank, a piece of land extending to three acres (1.2 hectares) was to be converted into a botanic garden "for the teaching and study of botany as pure Science, and as applied to the Arts and Industries, and for the furtherence of University interests and the public good" (1). In this benefaction, Anne Cruickshank wished to commemorate her brother, Doctor Alexander Cruickshank. As a family, the Cruickshanks already had strong links with the University for their father had been professor of Mathematics from 1817 to 1861. He had retired on the Union of Marischal and King's Colleges.

The buildings of the Old Aberdeen Gymnasium, a privately funded boarding school for boys, were also included in the benefaction. These buildings, which include the conspicuous Cruickshank Tower (fig 1), now form part of the Department of Plant Science.

EARLY HISTORY

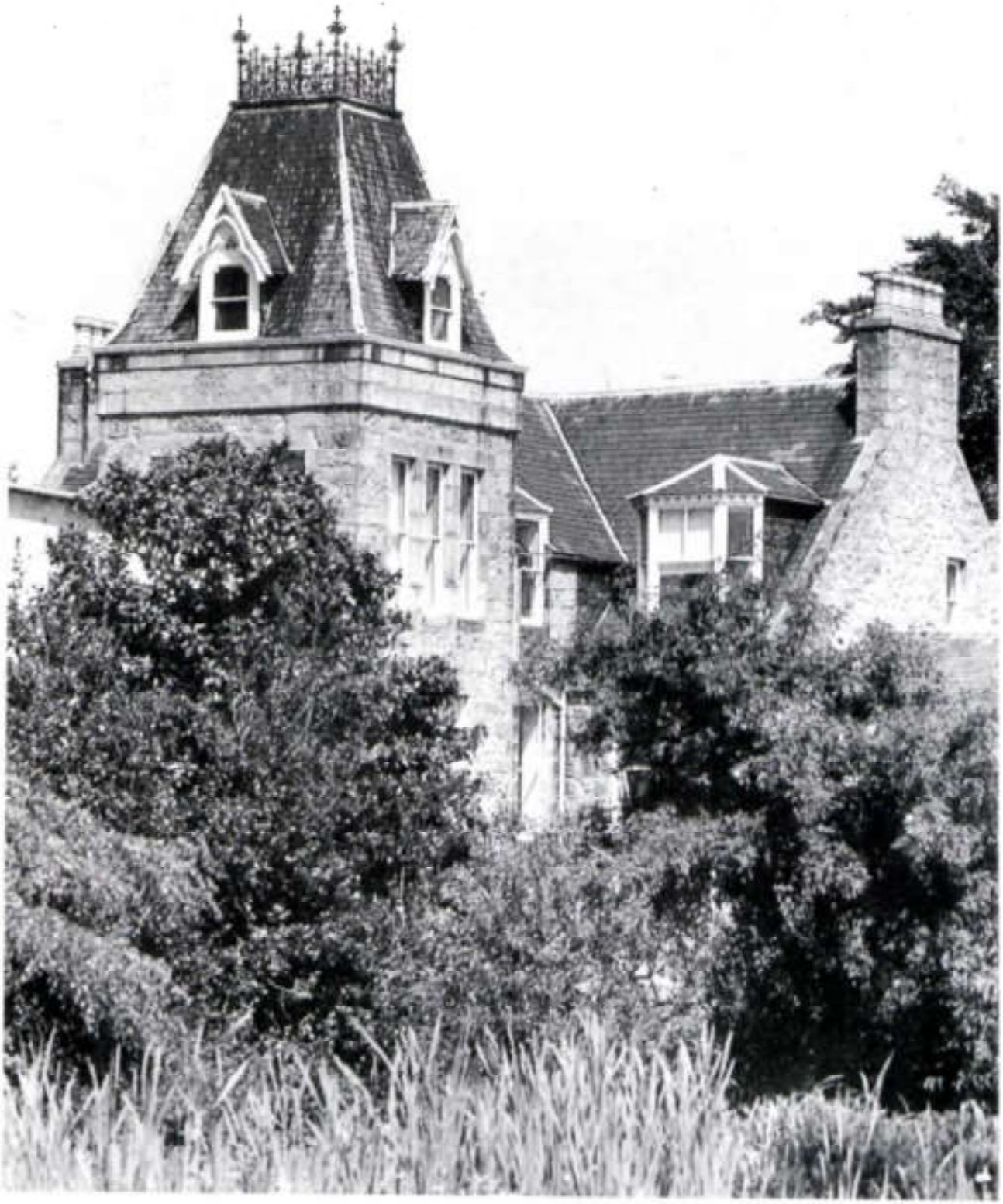
The Cruickshank Trustees were empowered to appoint a Keeper for the Garden "who may, if they think proper, be the Professor of Botany in the University". Professor Trail (fig 2) held the Regius Chair of Botany at the time and became the first Keeper of the Garden. He considerably altered and added to the Garden. The ground previously used by the Aberdeen Football Club was incorporated along with the leased ground and greenhouses of a small market garden. James Strachan was nurseryman of this garden and he became the first gardener at the Botanic Garden.

The extended garden was now almost six acres (2.43 hectares) and Professor Trail asked his friend Sir George Nicholson, the Curator of the Royal Botanic Garden at Kew, to provide a plan for the Garden. In this plan most of the Garden was divided into 130 narrow rectangular beds intending to display plants in a formal taxonomic arrangement. The north boundary wall was in a ruinous condition and Trail had this replaced with a very fine brick faced wall which still stands in the Garden (fig 3). Nicholson's design, however, disappeared at the start of the 1914-18 War when the Order Beds were turned over to vegetables.

No further developments occurred during Professor Trail's time in the Department of Botany, perhaps because he had too little time to devote to the Garden. At the time of his death, then, in 1919 and when little remained of the original Garden lay-out he was succeeded by Professor Craib.

Professor Craib came up to Aberdeen from Edinburgh and was a specialist in the Flora of Thailand and, although a taxonomist, might not have seemed to

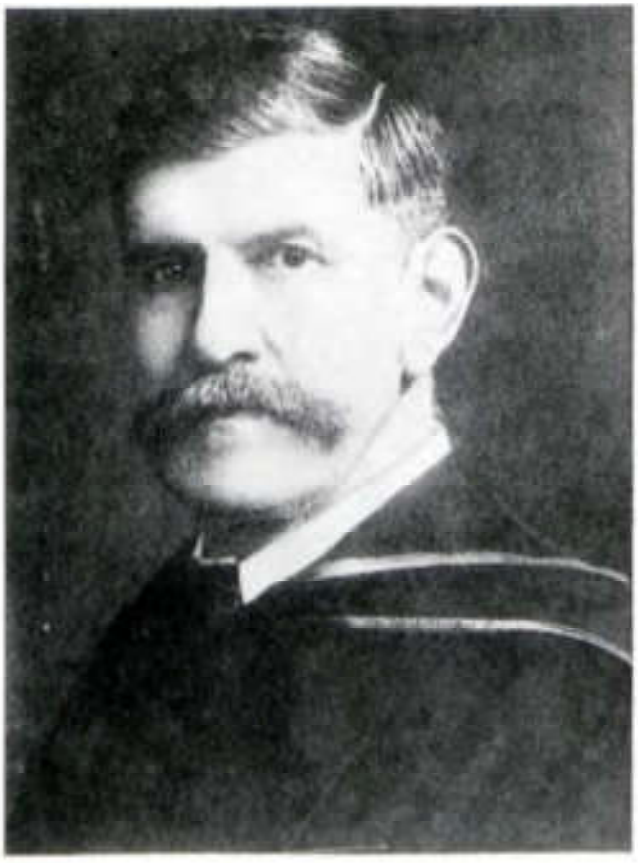
Cruickshank Tower



have much interest in the Garden. However, he set about completely restructuring the Garden. Two of our most important garden features were started by Professor Craib — the Long Border (fig 3) and the Sunken Garden. The formation of the Sunken Garden must have involved a lot of work. Terraces were made as well and lined with *Cotoneaster* hedges. It is clear that the feature was of a rather formal design. Professor Craib also planted many trees which are now reaching maturity and these together with those from Professor Trail's time form the framework for the garden.

During Professor Mathews' tenure of the Regius Chair of Botany, and barely a decade after its construction, the site of the Sunken Garden was chosen to house a very large air-raid shelter throughout the 1939-45 War. Once again the outbreak of war had caused considerable modification to an original design in the garden. After the war Professor Matthews redesigned the area while maintaining the sunken nature of the feature but radically altered the planting. It became an informal garden of dwarf conifers, rhododendrons and alpine plants in rock-bordered mounds and open scree.

Professor J.W.H. Trail



RECENT DEVELOPMENTS

Over the years the Sunken Garden has gradually become too overgrown to contain the alpines and in 1970 the first Curator of the Garden Dr Pritchard, constructed a fine New Rock Garden (fig 4) in the area of ground north of Trail's high brick wall. Entrance to this feature is through an original arch at the west end of the wall which now houses a recently discovered and locally made wrought-iron gate.

The New Rock Garden was constructed with 200 tons of Old Red Sandstone and, under the direction of the Head Gardener, Fred Sutherland, the staff set about implementing the planting design. A chain of linked pools runs through the design and the southern aspect has proved an excellent site for alpines, in particular the early flowering bulbs of *Narcissus, Crocus, Galanthus* and Iris. The long bed north of the brick wall and facing the New Rock Garden contains a good collection of woodland and ground cover plants of *Helleborus, Gentiana, Meconopsis, Trillium* and *Primula* together with three *Metasequoia glyptostroboides*, the largest dating from 1948 which was one of the earliest plantings in Britain after its discovery in Central China.

Developments in the Garden are still continuing and underway is the New Rose

Garden which has been designed to illustrate the history of the rose, and contains important species and early varieties of albas, centifolias, gallicas, bourbons and moss roses. The central feature is a sunken area of York stone which contains a formal planting of some recently developed perpetual large and cluster flowered roses.

We hold the national collection of *Aconitum, Gentiana, Mertensia and Omphalodes* and hope to play an increasing role in the conservation of native plants by extending our collection of Scottish plants. Our project is to develop a wild garden of native Scottish plants from seed material collected in Scotland.

The long border

The new rock garden

THE BOTANIC GARDENS, AARHUS

KAI LARSEN AND IVAN NIELSEN

Botanisk Institut Aarhus Universitet, Denmark

The Botanic Gardens in the city of Aarhus are divided into 4 parts.

1. The Forest Botanical Garden which is a municipal arboretum founded in 1923 with a total area of 8 ha. The arboratum harbours a good collection of trees from temperate N America and the Sino Japanese region. There is also a representative collection of Rhododendrons.

2. The Botanical Garden of the city was founded in 1911 and covers an area of 21, 5 ha. It is a garden built up on the classic way with herbaceous beds of annuals and perennials arranged in a systematic quarter, inclusive of Danish plants. A rock garden with species from the alpine-Himalayan region and a special rock garden for Rhododendron and other acidophilous species. The tree collection is quite extensive, there is a particularly large collection of Acer.

3. The greenhouses in the city Botanic Garden belong to the University of Aarhus under the administration of the Botanical Institute established in 1963. The glasshouses were constructed in the late sixties and consist of 5 houses with a total area of 2.000 m². Approximately 5,000 species are under cultivation, the majority of these are brought back from travels and expeditions by the staff members of the institute. The main houses are open to the public free of charge and the annual number of visitors are about 63,000 (1985).

A Survey of the 5 main houses is given below. Besides these the institute has 4 minor hot houses at its own premises, these houses are not open to the public, they hold collections of orchids, Zingiberaceae, Cactaceae and ferns from wild sources, mainly Thailand, Borneo, Java and Ecuador.

House 1 : Mediterranean climate. Besides the economically important species a good collection of Canarian endemics brought back from Gomera, Tenerife and Gran Canaria by staff members. An exposition of carnivores is also permanently placed here.

House 2 : Arid climate. Succulents including material of known wild origin, e.g. Cactaceae from Ecuador and various succulents from the Atlantic Islands.

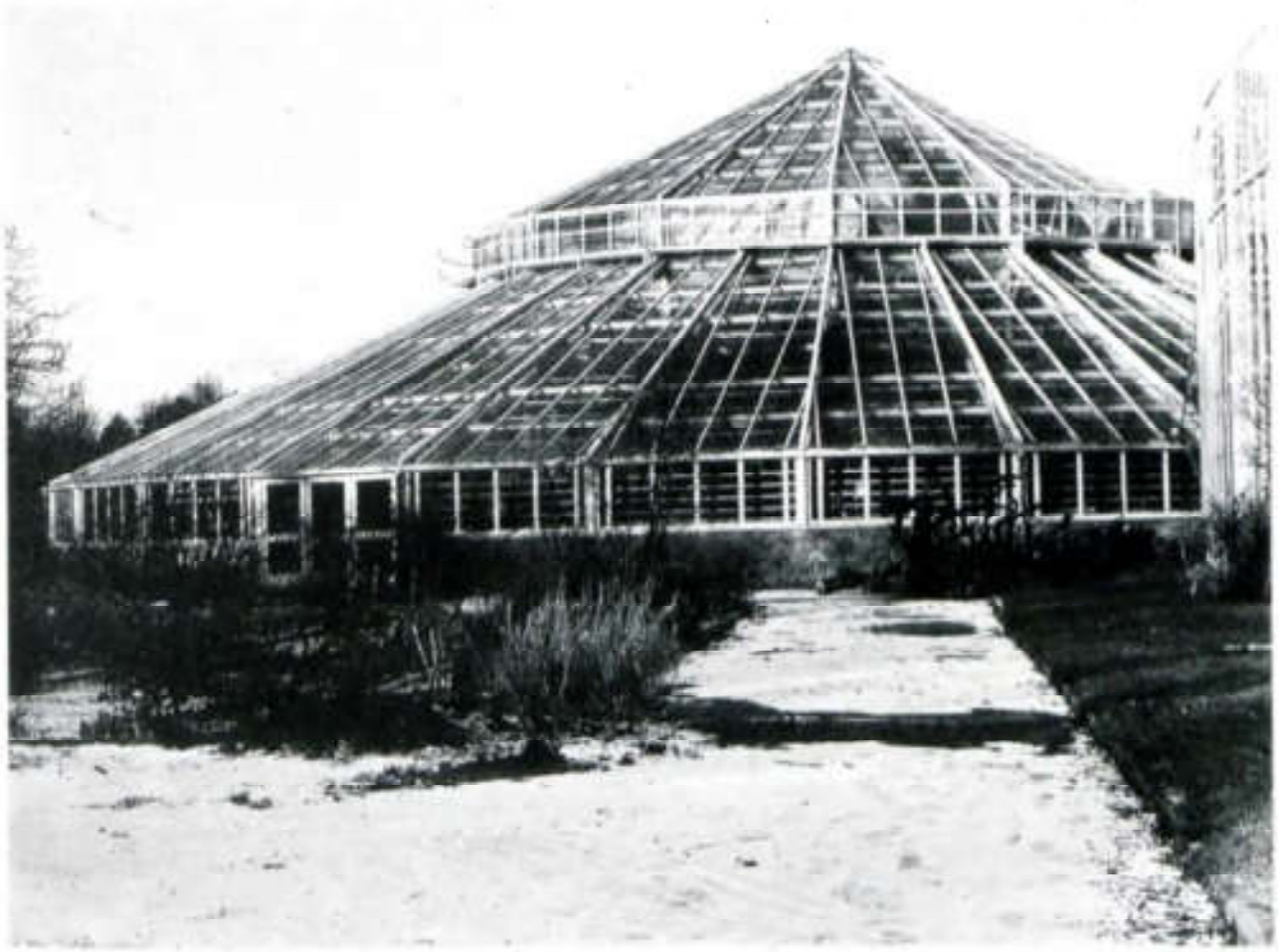
House 3 : Humid subtropical climate with summer rain. A variety of species including a fern collection which covers c ½ of the area. Several rare ferns from the tropics are under cultivation.

House 4 : Monsoon climate. This house was established to accommodate the collections from Thailand. Here e.g. endemic species of Zingiberaceae, Araceae, Bauhinia etc. are grown, also a number of rare and

endangered tropical SE Asian species as e.g. *Phyllanthodendron mirabile* (Euphorbiaceae), and several rare orchid species. Besides some economic plants as. e.g. *Vanilla planifolia, Manihot, Carica, Capsicum* etc.

4. The experimental field at Paaskehojgaard north of Aarhus covers an area of 5 ha for growing wild species from the temperate regions studied at the institute; here a large collection of Central and S-European *Alchemilla* species are grown

Part of green house in winter

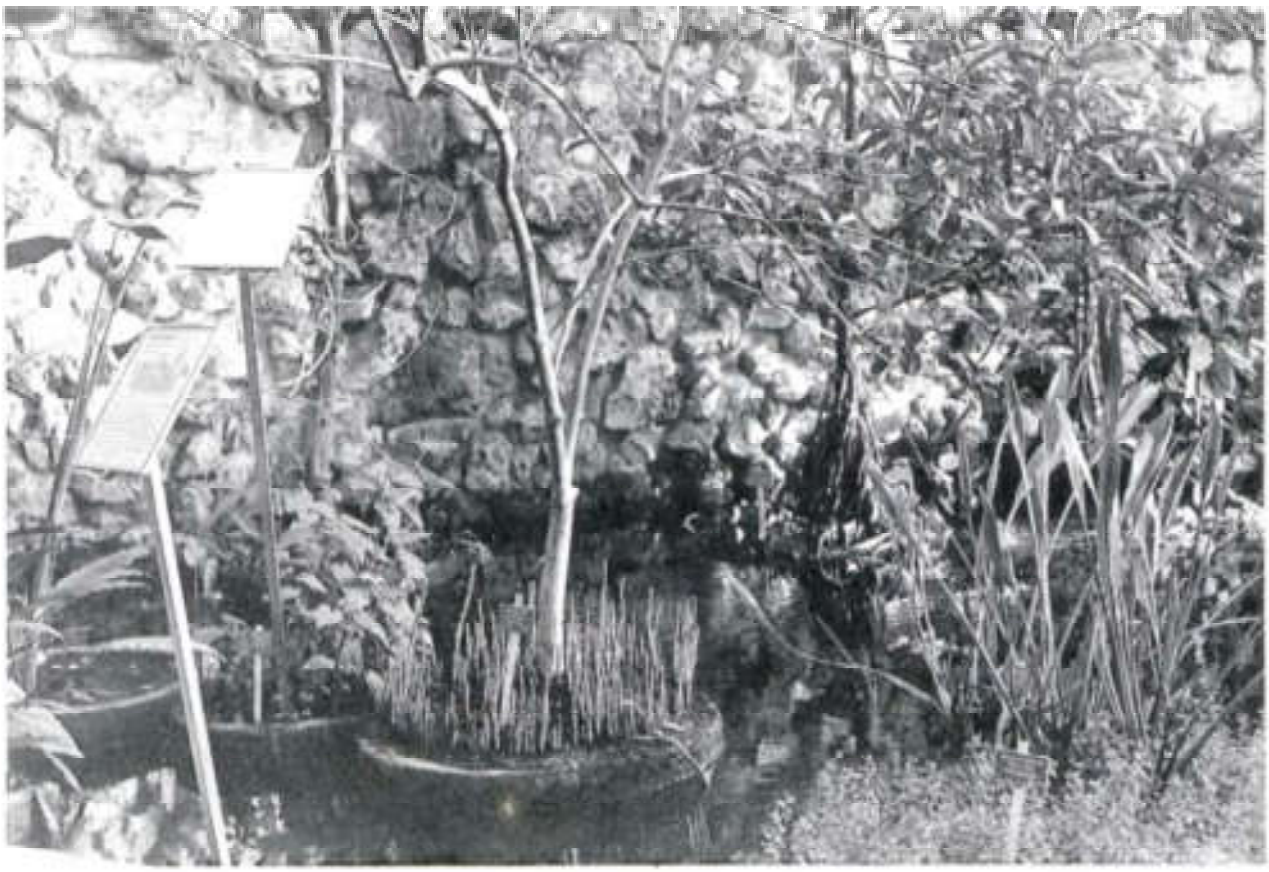


House 5 : The largest house with an area of 1,000 m² and 18 m high. It represents the humid tropics. A basin with waterplants and mangrove species as *Aegiceras, Bruguiera, Avicennia, Rhizophora, Acanthus ilicifolius* is situated here; there are also groups of botanical *Ficus* spp., Euphorbiaceae, Piperaceae, Bromeliaceae, Begoniaceae, Areccaceae, Musacae are found. Rain forest plants from Ecuador and SE Asia predominate.

representing 500 agamospecies in 700 collections mainly from SE Europe ad N, Spain. Also representative collections of *Iris, Allium,* European pteridophytes are cultivated.

Glasshouses of 500 m² are used for subtropical species and high Andean species studied at the institute. There is no admittance for the public, but visits can be arranged.

Dracaena Draco from the Succulent house



Avicennia, Bruguiera along with *Bacopa* and *Sagittaria* in the Tropical House

Succulent House

THE INDIAN BOTANIC GARDEN : EARLY HISTORY AND ITS FUTURE ROLE IN PLANT CONSERVATION (1787 – 1987)

M. P. NAYAR AND R. K. CHAKRAVERTY

Botanical Survey of India, Calcutta, India.

EARLY HISTORY

The Indian Botanic Garden formerly known as East India Company's Garden at Howrah is situated on the west bank of river Hooghly flowing through the twin cities of Calcutta and Howrah. The Garden at present spans about 273 acres (110 hectares) though it initially had 310 acres of land. The beginning of the garden was due to the indefatigable zeal of a military officer at the Fort William, Col. Robert Kyd (1746-1793) who had a private garden at Shalimar in Howrah. Robert Kyd grew plants of economic importance in his private garden. The recurrent famines occurring in Bengal due to food shortage and also the need for the cultivation of spice and introduction of economically important plants to alleviate the sufferings of the people prompted Robert Kyd in initiating a proposal for the establishment of a garden under the East India Company's patronage at Howrah-Calcutta. The East India Company which was a trading company had through conquests both in the land and sea occupied a premier position as arbiter of the destinies of the Indian subcontinent due to the feuding Kings and Chieftains of India on the eve of the decline of the Moghul empire in North India and warring feudal Kings in the southern India. Trade in spices, plant products and timber for ship building were also essential for the Company. It was at this turn of history that Robert Kyd in 1786 proposed to Sir John Macpherson, then Governor General of the East India Company for the establishment of a Garden for horticultural and economically important plants. This proposal was finally endorsed by the Court of Directors of the East India Company at London in a letter dated 31st July, 1787. The Company had long range vision as this was a time and era when there were keen rivalries among european nations for the monopoly of trade in oriental spices and commerce of plant products. The european nations vied with each other in fighting naval battles for the command of sea routes in order to establish trading out posts in South East Asia, Africa, and in the New World. The trading posts in the course of years had become fortresses of colonial out-posts. For the sustenance of the East India Company, trade, export of plant products and timber for ship-building was necessary. It was a period when industrial activities were in its nascent stage and the industrial revolution had to wait for another six decades.

Col. Robert Kyd in addition to his own responsibilities, as Secretary of the Military Board at Fort William, functioned as Honorary Superintendent of the Garden from 1787 to 1793. During his tenure he worked with great enthusiasm and introduced many economically important plants in the Garden. Cardamum, pepper, nutmeg,

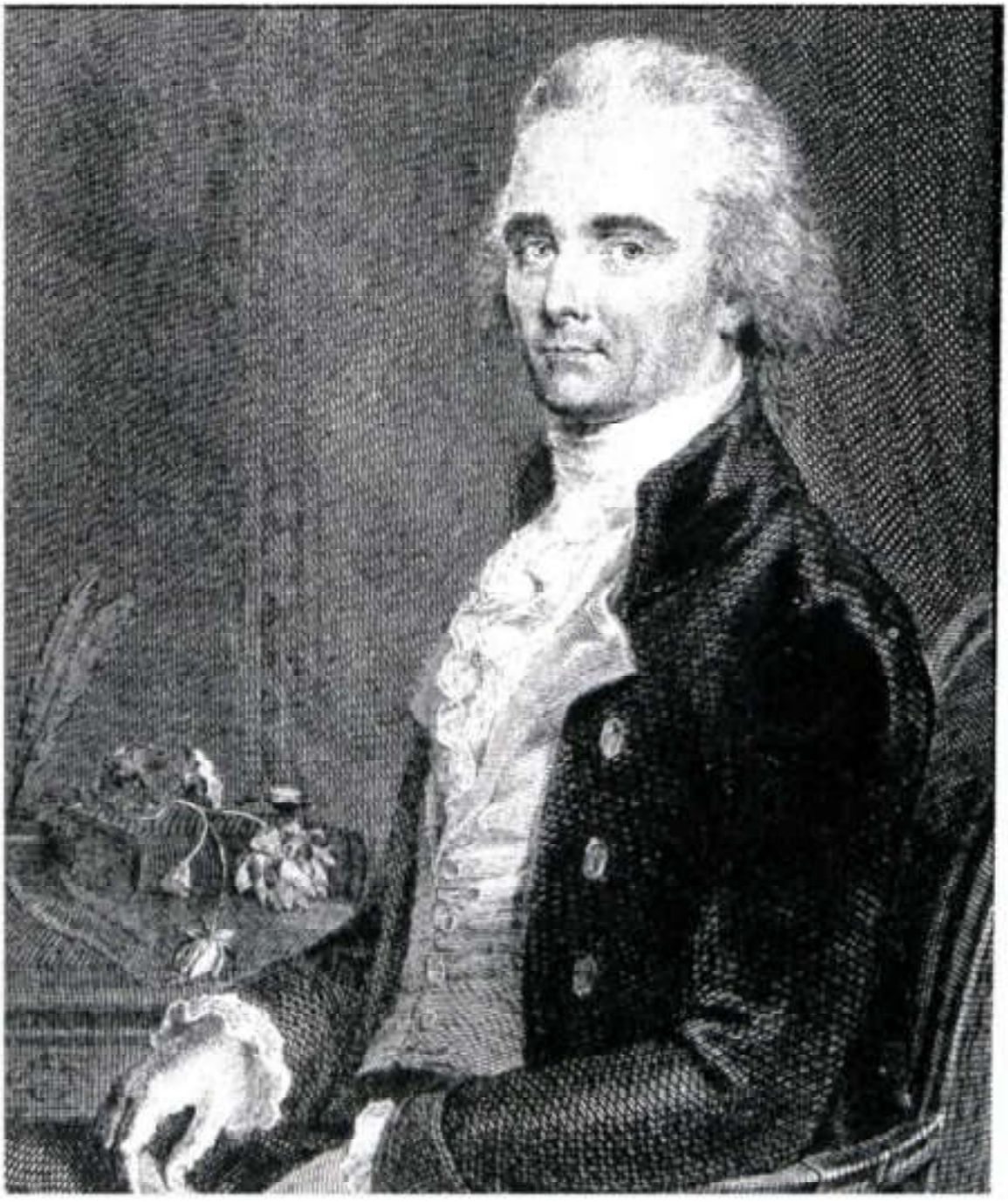
cotton, tobacco, indigo, coffee, sago and teak. During the summer of 1793 Robert Kyd fell ill and he passed away on 18th May, 1793. He was cremated in the South Park Street Cemetry, Calcutta. A monument in honour of Robert Kyd was erected in 1795 during the tenure of William Roxburgh with the following inscriptions: "Roberto Kyd, mil, trib, horti Foundatori : posivit A. K. MDCC×CV".

William Roxburgh (1751-1815) was appointed as the first salaried Superintendent in 1793. The destinies of the Garden as proposed by its founder, changed to a large extent towards taxonomy during the tenureship of William Roxburgh. Having closely connected with Koenig and influenced by the linnean classification, William Roxburgh besides his interest in the development of the Garden laid the foundation of taxonomy in India and he established a large Herbarium. Since he stayed inside the Botanic Garden, the Government built a house for Roxburgh in 1795 on the banks of the river Hooghly inside the Botanic Garden which is known today as "Roxburgh House". During his

Col. Robert Kyd, Honorary Superintendent of Botanic Garden (1787-1793)
Courtesy: Director, Royal Botanic Gardens, Kew,

tenureship he published Hortus Bengalensis (1814), Flora Indica (1820-24). Hence he is rightly called as the "Father of Indian Botany". He left behind a large collections of coloured Icones, original drawings (about 2533), using mostly vegetable dyes. These drawings are of immense value for the identification of species. Roxburgh due to failing health resigned the job and proceeded to his home Edinburgh and he

Dr. William Roxburgh, first salaried Superintendent of Botanic Garden (1793-1814).
Courtesy : Director, Royal Botanic Gardens, Kew.



expired on 18th February, 1815; he was interned in the Grey Friars Churchyard. His admirers erected a monument inside the Garden on the top of a small mound near the Great Banyan tree. Bishop Heber wrote a Latin transcription of the tribute. In English it reads as follows :

"Whoever you be
If this place sooth the mind with its sweetness
Or teaches you to think of God with reverance
You must hold in high honour Roxburgh
Formerly the Superintendent of these Gardens.
A man distinguished for his Botanical Science
And most able planner or restic pleasure
His country preserves his remain
Here lives his genius
May you enjoy thoroughly
To his cherished memory"

His surviving friends A.D. 1822.

Roxburgh was succeeded by a very distinguished scholar Thomas Henry Colebrooke (1765-1837) and he functioned as Superintendent from 1813-1814 for one year. On asking leave for retirement, Buchanan Frances Hamilton (1762-1829) took charge for a short period for two years (1814-1815). Due to ill health he also resigned. When Buchanan left India, the stewardship of the Garden appropriately came to Nathaniel Wallich (1786-1854), Danish surgeon (student of Martil Vahl), taken prisoner at Serampore due to Anglo-Danish war and later released at the intervention of William Roxburgh. The botany of the Garden and scientific contributions of Nathaniel Wallich during the stewardship of the Garden from 1816-1817, 1817-1847 is encyclopaedic as contributions of Nathaniel Wallich are well documented. His lasting contribution is the

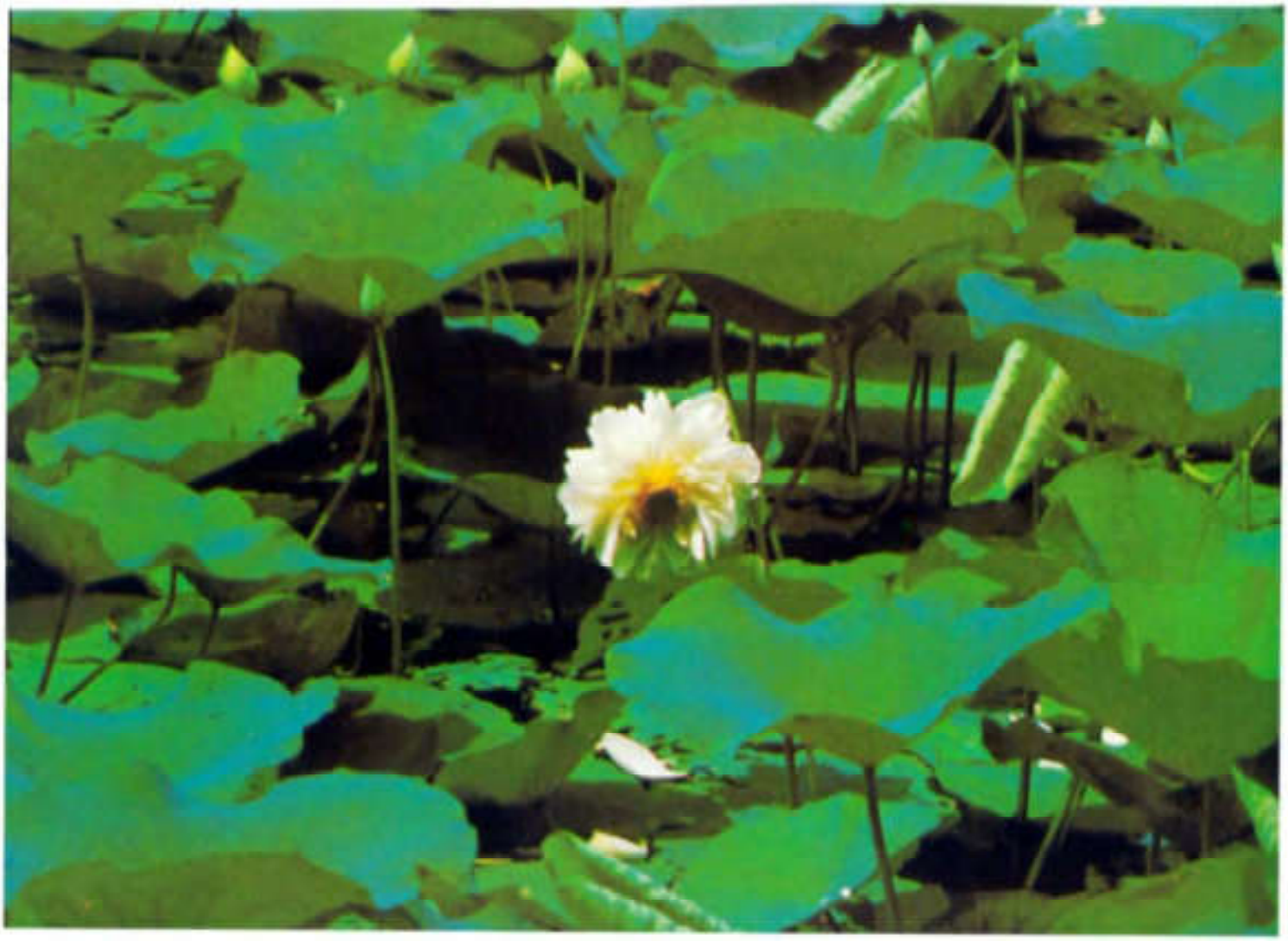
A portion of the Great Banyan tree.

monumental work (i.e.) Wallich's Catalogue of Herbarium specimens. *"A numerical list of dried plants in the East India Company's Museum"* — lithographed during the years 1828-1849. His other important publications are "Plantae Asiaticae Rariores - (1830-1832) in 3 volumes and "Tentamen Florae Nepalensis Illustratae (1824-1826). During his tenureship he played a valuable role in the introduction of tea and surveyed Nepal and North Eastern India. He contributed significantly to the introduction of tea in India. Nathaniel Wallich died at the age of 68 years on 28th April, 1854 at his house in Upper Gover Street in London. His admirers erected a monument inside the Botanic Garden near the Bambusetum and inscribed as below :

> "In honour of Nathaniel Wallich, MD., FRS. For thirty years Superintendent of this Garden. A most distinguished botanist and indefatigable explorer. OB. TT MD CCCLIV."

Before closing the great saga of contributions of Nathaniel Wallich it is worth recording Nathaniel Wallich had his own saga of misfortunes. Though Roxburgh in 1809 secured an appointment in the Garden for Wallich and he stayed in the Garden with Roxburgh, his appointment

Nelumbo nucifera : White Cultivar



did not materialise. Wallich with disappointment, returned to Serampore. Again after acting for one year (1815-1816) as Superintendent, Wallich was relieved of his duties by James Hare, a junior member of the Medical Board of Calcutta and later Thomas Casey for the period from 1816-1817.

TEA & INDIAN BOTANIC GARDEN

The history of tea introduction is another great chapter of the history of the Indiar Botanic Garden. Though tea was successfully cultivated in the Indian Botanic Garden from Canton (China), it had not received sufficient interest among commercial circles for the development of tea as a plantation crop. Mr. Walker, a member of the East India Company's Board of Directors in London, having read about tea from Francis Buchanan's account at India House Library, moved the East India Company through the then Governor General Lord William Bentinck to appoint a Tea Committee. Nathaniel Wallich, G. J. Gordon and William Grant (1788-1865) were members of this Committee. Wallich's seed collector Robert Blinkworth on Wallich's advice tried tea plantation in Garhwal hills. Wallich volunteered to act as secretary of the Tea Committee. in 1823 Robert Bruce travelling up the Brahmaputra after contacting the Singphos Village tribes near the Burhi Dihang river came to know that the tea was prepared locally from tea bushes growing in the village. Later Robert Bruce's

Central National Herbarium, built During (1965-1969).

younger brother Alexander Bruce followed up his brother's interest. Captain Andrew Charlton, a new political officer, brought seedlings of tea to the Garden from the same village (Singphos). It was Francis Jenkins (1793-1855) who in 1834 followed up the cultivation of tea for large scale trial in the Indian Botanic Garden and he forwarded to Wallich samples of tea. Wallich identified this sample as *Camellia theifera,* the source of tea. The main point that is being emphasised here is that the Indian Botanic Garden laid the foundation of this thriving cash crop of India, tea and the Garden has earned its bread for many generations to come.

During Nathaniel Wallich's (as his health failed in 1842) absence on leave for the years 1842-1845, William Griffith (1810-1846), a student of Lindley acted as Superintendent (1842-1845). Before joining the Garden, Griffith worked for the Tea Committee and worked with Wallich for tea exploration and other collection work in the gangetic plain and

Victoria amazonica

their relationships were one of love and hate as each vied with each other for the completion of the work left behind by William Roxburgh. William Griffith was critical of Nathaniel Wallich's maintenance of the garden and in a letter addressed to Robert Wight he mentioned "That the Government have approved all my suggestions and plans for the improvements of the Garden. My plans are for a Natural Garden flanked by a garden of medicinal plants and a garden illustrating the useful plants of Lower Bengal". As soon as Nathaniel Wallich resumed duty, William Griffith's ideas were not taken up and Griffith left for Malacca. Due to failing health, Griffith passed away in 1846 at an young age of 36. In an address to British Association in 1899 Sir George King mentioned William Griffith as follows

> "No botanist [of India] ever made such extensive explorations nor himself collected so many specimens (about 9000) as Griffith did during the brief thirteen years of his Indian career none ever made so many descriptions of plants from living specimens. His botanical predecessors and contemporaries were men of ability and devotion. Griffith was a man of genius"

A monument was also erected inside the Garden in honour of William Griffith.

Though large number of plants and dried specimens were collected during these periods, there was complete neglect of organised Herbarium collections and in all probability Wallich did not think of establishing a good Herbarium in Calcutta and it was reported that he was pessimistic about keeping good herbarium collections in the mid climate of Calcutta

Hugh Falconer succeeded Nathaniel Wallich though McClelland, a close friend of Griffith, looked after the Garden temporarily. J. D. Hooker when he visited the Garden in 1848 (Himalayan Journal, page 2, 1891) commented the condition of the Garden as follows "There had been a great want of judgement in the alteration made since Dr Wallich's time when they were celebrated as the most beautiful gardens in the East and were the great objects of attraction to strangers and towns people I found instead an unsightly wilderness, without shade, (the first requirement of every tropical garden) or other beauties than some isolated grand trees, which had survived the indiscriminate destruction of the useful and ornamental which had attended the well-meant but ill-judged attempt to render a garden a botanical class-book.....I was surprised to find the Botanical Garden looked upon by many of the Indian public, and even by some of the better informed officiel men, as rather an extravegant establishment, more ornamental than useful These persons seemed astonished to learn that its name was renowned throughout Europe and that during the first twenty years especially of Dr. Wallich's superintendence, it had contributed more useful and ornamental tropical plants to the public and private gardens of the world than any other establishment before or since. ..... Amongst its greatest triumphs may be considered the introduction of the tea plant from China, a fact I allude to as many of my English readers may not be aware that the establishment of the tea-trade in the Himalaya and Assam is almost entirely the work of the superintendents of the gardens of Calcutta and Saharanpore."

Hugh Falconer (1808-1865) though arrived alongwith Griffith, worked in the Gangetic Plain and took charge of Saharanpur Botanic Garden after Royle's retirement. He was appointed Superintendent in 1847 and he did renovation of the Garden during the period 1847-1855 J. D. Hooker meanwhile was botanising in

north-eastern India from 1848 to 1851. Dr. Thomas Thompson (1817-1878), a friend of Hooker, joined him for their plant collection during the period. J. D. Hooker (Himalayan Journal pp. 464-465, 1891) described in 1850 the condition of the Botanic Garden under Falconer's stewardship as follows : "The destruction of most of the palms and of all the noble tropical features of the gardens during Dr. Griffth's incumbency had necessitated the replanting of the greater parts of the ground, the obliteration of old walks and the construction of new; ..... The avenues of Cycas trees *(Cycas circinalis)* once the admiration of all visitors and which for beauty and singularity was unmatched in any tropical garden had been swept away by the same unsparing hand which had destroyed the teak, mahogany, clove, nutmeg and cinnamon groves. In 1848, when I visited the establishment, nothing was to be seen of its former beauty and grandeur — The rapidity of growth is so great in this climate, that within eight months from the commencement of the improvements, a great change had already taken place. The grounds bore a park-like appearance; broad shady walks had replaced the narrow winding paths that ran in distorted lines over the ground and a large Palmetum, collection of tall and graceful palms of various kinds occupied several areas at one side of the garden; whilst a still larger portion of the ground was being appropriated to a picturesque assemblage of

Jackmond's bridge.

certain closely allied families of plants This, which the learned Director called in scientific language a Thamno-Endogenarium, consists of groups of all kinds of bamboos, tufted growing palms, rattan canes *(Calami)*, Dracaenae, plantains, screwpines *(Pandani)* and such genera of tropical monocotyledons plants.....The great Banyan tree *(Ficus indica)* is still the pride and ornament of the garden. Dr Falconer has ascertained satisfactorily that it is only seventy[five years old.....The tree is now eighty feet high and throws an area of 300 ft. in diameter into a dark, cool shade. The gigantic limbs spread out about ten feet above the ground and from neglect during Dr. Wallich's absence, there were on Dr Falconer's arrival no more than eightynine descending roots or props There are now several hundreds and the growth of this grand mass of vegetation is proportionably stimulated and increased.. .....Cycas trees abound in the gardens and though generally having one or rarely two crowns, they have sometimes sixteen and these stems are everywhere covered with leafy buds"

Thomas Thomson (1812-1878) succeeded Falconer in 1855. Thomas Thomson was a classmate of J. D. Hooker while studying at the University of Glasgow. He entered East India Company's service in 1839 and later he joined Hooker's collection tour at Darjeeling in 1850. Thomson on joining the post of Superintendent in 1855, started organising the general Herbarium out of the several stocked bundles lying unattended. As a friend of J. D. Hooker he received the collections of Hooker. Besides he received some of Wallichian Collections from Kew which Calcutta lost during Wallich's time Thompson was more of a herbarium taxonomist then a Garden Organiser This change over indirectly helped the development of the Herbarium. Meanwhile in 1857, following Queen's proclamation, the East India Company's affairs were taken over directly by the crown. Since then the Garden was known as the Royal Botanic Garden Alongwith Hooker, Thomson started Flora Indica but his ill health prevented in furthering the pursuit and he retired in 1861

Thomas Anderson (1832-1870) succeeded Thomas Thomson in 1861 and held the post of Superintendent from 1861-1867.

CINCHONA & INDIAN BOTANIC GARDEN

At the instance of the Government of India, Thomas Anderson played a significant role in the introduction of Cinchona trees in India on the basis of Forbes Royle Report (1853) who recommended its cultivation in the Nilgiri hills. Thomas Anderson took special interest in personally looking after the seeds he brought from Kew in 1861, but also raised several species of Cinchona for trial at the Calcutta Botanic Garden. Anderson, in 1862 introduced the Cinchona cultivation on the Sikkim Himalayas and raised about 2000 plants. The introduction of Cinchona and cultivation at Darjeeling helped the Government to a large extent in alleviating malarial fever and the Calcutta Botanic Garden could take its pride in the administration of Cinchona plantations and distribution of quinine at a reduced price to people afflicted with the malarial disease. Anderson's preoccupation in the Cinchona cultivation resulted in the decay of the Herbarium which Thomas Anderson assembled at great pains Thomas Anderson however could get the services of Jean Baptiste Louis Pierre (1835-1905), a Botanist of French origin, working at the herbarium on honorary capacity out of sheer love for taxonomy. Wilhelm Sulpiz Kurz (1833-1878), it was reported that he

fled from his native land Germany and worked in Java under a pseudonym. He finally found himself landed at the Herbarium of the Calcutta Botanic Garden in 1864 due to the interest taken by Anderson when he visited Java. Finally the Government appointed both Pierre and Kurz as Curators. Kurz's contribution on the Flora of Andaman and Burma are noteworthy. The Forest Flora of Burma (1877) by Kurz in two volumes is a very important contribution of an unexplored territory. In the Botanic Garden, there is a monument erected in his honour which is inscribed as follows :

"Sulph Kurz, Curator of the Herbarium in this garden; Born at Augsberg 8th May 1834; Died at Penang 16th January 1878; Erected by his friends in memory of his botanical researches in the Malayan Archipelago, Burma, India; Sculptured by Dowling."

To the misfortune of the Botanic Garden it faced a great disaster in 1863 when Anderson was in charge. Spring tidal waves estimated to 5 to 8 m. height from the river Hooghly drove into the garden destroying the lakes and bringing in salt water. Added to this, cyclonic storm toppled almost all the trees. Only the Great Banyan tree, few Mahoganies and some palms withstood the onslaught.

It is not out of place to mention another luminary — Charles Baron Clarke (1832-1908) third wrangler mathematician from the Cambridge University had arrived in Calcutta in 1866 for teaching in the

William Roxburgh's monument erected in 1822.

Presidency College, Calcutta. C. B. Clarke frequently visited Khasia hills during vacation. He had a love for plants. Due to failing health of Anderson, C. B. Clarke was appointed to act as Superintendent for the period 1869-1871. Since he took charge of the Cinchona plantation at Mungpu, he started collecting plants in Sikkim. As C. B. Clarke was in the education service, between his teaching jobs, he studied families, Cyperaceae and Commelinaceae in great detail and precision justifying his qualification of a great mathematician. The specimens in the Herbarium which he drew and annotated are still shining examples of great quality and precision which succeeding generation of botanists could examine and study.

Surgeon Captain George King (1840-1909) who spent six years in India was appointed as the Superintendent of the Garden in 1871 succeeding Thomas Anderson. A qualified medical graduate of the University of Aberdeen, he spent a short spell at Saharanpur (1868) and at Dehra Dun (1869-1870). Besides Superintendentship of the Garden, George King functioned as Professor of Botany, Medical College and also Superintendent of Cinchona plantations. George King, a visionary on his own right proposed that the botanists under various provincial Governments could be united into an organisation called Botanical Survey of India and he was appointed as the first Director of the Botanical Survey of India in 1890. By this time the governance of the country was also divided into several provincial governments. The Garden and the Botanical Survey of India came rightly under Imperial Government of India and George King supervised all the provincial gardens and botanists.

During King's superintendentship the Herbarium and the Garden developed as a premier centre of research and the Garden again attracted the world's attention. The British empire, having consolidated its empire building was equally generous in funding. A new Herbarium building was built in 1882 and the herbarium specimens were arranged in the Bentham & Hooker's systems of classification. Taxonomic revisions, floristic explorations and botanical monographs and State Floras were published during this period. The publication of Hooker's Flora of British India (1872-1897) edited by Sir J. D. Hooker, Director of Kew Gardens and assisted by botanists, who returned on leave from India, contributed tremendously to the development of botanical science in India.

RUBBER AND INDIAN BOTANIC GARDEN

Sir J. D. Hooker, Director of the Royal Botanic Gardens, Kew gave to George King in 1873, six plants of Para rubber tree (*Hevea brasiliensis*) which he brought to Calcutta. Since the climate of Calcutta was not suitable, King sent wardian cases of *Hevea* seedlings to other climatically suitable areas in the empire, Burma, Malaya, Ceylon and South India.

Again, the timber yielding Mahogany from the West Indies was first introduced to the Indian Botanic Garden. These trees were successfully grown and inspite of ravages of time and cyclone, Indian Botanic Garden can still boast of famous avenues of Mahogany trees. J. D. Hooker keen as he was in establishing close links with Indian Botanic Garden, was generous in supplying through Kew different species of Mahogany in large quantities. After Kurz's tenureship of Curator in 1878, Lewis Jones Knight Bruce (1852-1938) joined the post of Curator nominally upto 1886. Another luminary David Prain (1857-1944) who was destined to play a prominent role in the destines of the Indian Botanic Garden and Kew Gardens as future Director of these two important Gardens

joined the post of Curator under George King in 1887. As time went on, George King by the nature of administering a large empire of botanic gardens and botanists in a loosely jointed federal structure got more involved in administration. David Prain after his qualification on medicine from Aberdeen and Edinburgh joined the Indian Medical Service. He held the post of Curator from 1887 to 1897 and he succeeded George King and held the post of Superintendent upto 1905. In 1905, David Prain (Later knighted as Sir David Prain) was appointed as Director of the Royal Botanic Gardens, Kew and he occupied this chair with distinction until 1922. This was also a time when the major provincial Floras of India *viz.* Gamble's Flora of Madras Presidencey, Cooke's Flora of Bombay Presidency, Duthie's Flora of Upper Gangetic Plains and Prain's Bengal Plants appeared in the Indian Botanical horizon enlivening the taxonomy of India.

After David Prain's tenure (1897-1905) Lt. Col. Gage occupied the chair of superintendentship from 1906-1923 and during his period several unexplored regions were surveyed. William Wright Smith officiated as Superintendent during the absence of Lt. Col. Gage in 1908. In 1923, C. C. Calder succeeded Lt. Col. Gage and he was in charge of the Garden from 1923-1937. The two great world wars sapped the requirements for the maintenance of the Garden and Herbarium. The loosely federal Botanical Survey of India was short lived. Meanwhile agricultural and foresty departments have taken over some of the utilitarian functions of the Botanical Survey of India. In fact Botanical Survey of India became nonfunctional due to shortage of funds and more significantly did not show its resilience for facing the new needs of the country. Taxonomy is a hand maiden for generating all activities connected with economic botany, conservation and germplasm studies. However, taxonomy in India as elsewhere was pursued with a narrow academic interest and this caused its downfall during the years of financial stringency. C. C. Calder was succeeded by Kalipada Biswas who held the post of Superintendentship from 1937-1955. In 1947 India gained independence and in 1950 appropriately the word "Royal" was changed to "Indian" for the Botanic Garden. During K. Biswas's tenureship the garden made great strides in the maintenance

World Environmental day — Sit and draw competion for children.

and development. He was succeeded by taxonomist Debabrata Chatterjee who occupied the chair untill 1960. J. Sen succeeded Debabrata Chatterjee from 1961 1963. From 1963 the Garden again changed hands from the provincial Government to Central Government as Botanical Survey of India was reorganised in 1954 on the lines of Sir George King's original plan but controlled fully under the Central Government.

The Herbarium of the Indian Botanic Garden was taken over in 1957 by the Botanical Survey of India and developed as the Central National Herbarium under the Botanical Survey of India. The Indian Botanic Garden was transferred to the Botanical Survey of India during the year 1963 and the Superintendent of the Garden was designated as Deputy Director (Scientist D) in-charge of the Garden with responsibility of administering and developing the Garden. J. Sen became the first Deputy Director in-charge of Indian Botanic Garden under the Botanical Survey of India.

BOTANIC GARDEN AGAIN UNDER BOTANICAL SURVEY OF INDIA FROM 1963

Indian Botanic Garden is known throughout the world as one of the best landscape botanical gardens of the world where natural scenic beauty is preserved. Unlike other gardens in India which turned into either horticultural gardens or fruit gardens under the aegis of agricultural departments, this Garden preserves the best collections of native and exotic species and several endangered species. Compared to other gardens, there is less concrete and masonery inside the garden and there is more plants and canopy of trees. The Garden is proud of its rich collections of Palms, Bamboo, Pandanus and Bougainvilleas besides the well known Great Banyan tree and the Large Palm House

The Central National Herbarium previously housed in the Old Herbarium Building (built in 1882) required more space for housing valuable collections. A four storied building was built during the period between 1965-1969 and the Herbarium was transferred to the new building during 1970 1971. The Herbarium houses 1,380000 specimens. During the period several improvements regarding the strengthening of revetment wall along the river Hooghly side was taken up and completed. The old wall surrounding the Garden was in a dilapidated stage due to the tidal and cyclonic storm of 1978. A new wall raising the height to 3 m. with barbed wire fencing of 1 m. is under construction surrounding the Indian Botanic Garden excepting the river frontage in order to avoid pilferage

The Garden had to face a severe cyclone during September, 1978 following a raise of tide in the river Hooghly which overflowed the banks and the Garden was completely submerged under 1 to 2 m. of water causing great havoc to plants and trees. The silt laden tidal waves and salt water destroyed the beautiful lakes and chocked them with silt and mud.

Several trees were uprooted. This cyclone and tidal inundation was equal in fury compared to that of the 1863 cyclone during Thomas Anderson's superintendentship.

BAMBOO COLLECTIONS

The Indian Botanic Garden is proud of its collection of bamboos and there are twenty six species of Bamboos. The important species are mainly, *Bambusa arundinacea, B. burmanica, B. balcooa, B. glaucscens, B. gracilis, B. tnoeta, B spinosa, B. nana, B. tulda, B. vulgaris, Cephalostachyum pergracile, Dinochloa maclelandii, Dendrocalamus brandisii, D gigantcus, D strictus, D longispathus,*

Gigantochloa verticillata, Melocanna bambusoides, M. humilis, Neohouzeana dullooa, Ochlandra travancorica, Oxytenanthera abyssinica, Phyllostachys marliacea, Thyrsostachys oliveri, T. siamensis. It is proposed to supplement these collections with more species from South East Asia so that the Bamboo collections of Indian Botanic Garden can become an important source of germplasm for distribution to other gardens.

PALM COLLECTIONS

The Indian Botanic Garden is well known for its native and exotic palms. Basu & Basu (1978) enumerated a census of palms cultivated in the Indian Botanic Garden. Blatter (1926) published the book "Palms of British India & Ceylon". Some of the well known species in Indian Botanic Garden are — *Accelorhaphe wrightii, Actinorhytis, calapparia, Aiphanes acanthophylla, A. caryotaefolia, Archontophoenix alexandarae, A. cunninghamiana, Areca catechu, A. macrocalyx, A. triandra, A. engleri, A. obtusifolia, A. undulatifolia, A. pinnata, A. wightii, Bactris gasipaes, B. major, Bentinckia nicobarica, Borassus flabellifer, Calamus arborescens, C. ciliaris, C. erectus, C. garuba, C. leptospadix, C. longisetus, C. rotang, C. viminalis, Calyptrocalyx spicatus, Caryota mitis, C. rumphiana, C. urens, Chamaedorea elegans, Chrysalidocarpus lutescens, C. madagascariensis, Coccothrinax argentea, C. crinita, C. dussiana, C. inaguensis, Cocos nucifera, Corypha elata, C. taliera, C. umbraculifera, Daemonorops didymophylla, D. jenkinsiana, Desmoncus horridus, Dictyosperma album, Elaeis guineensis, Heterospathe elata, Howeia belmoreana, Hyophorbe lagenicaulis, H. verschaffeltii, Hyphaene bussei, Hyphaene natalensis, H. indica, H. schatan, H. thebaica, Latania*

World Environment day — Conducted tours for children

loddigesii, *L. lontaroides*, *Livistona grandis*, *L. jenkinsiana*, *L. saribus*, *Lodoicea maldivica*, *Normanbya normanbyi*, *Nypa fruticans*, *Orbignya cohune*, *Phoenicophorium borsigianum*, *Phoenix acaulis*, *P. loureiri*, *P. paludosa*, *P. reclinata*, *P. roebelini*, *P. rupicola*, *P. sylvestris*, *P. zeylanica*, *Plectocomia assamica*, *Pritchardia pacifica*, *Ptychosperma elegans*, *P. macarthuri*, *Rhapis humilis*, *R. excelsa*, *Rhopaloblaste augusta*, *R. singaporensis*, *Rhopalostylis sapida*, *Roystonea boringueana*, *R. oleracea*, *R. regia*, *Sabal blackburniana*, *S. mauritiiformis*, *S. mexicana*, *S. minor*, *S. palmetto*, *Salacca edulis*, *Scheelea insignis*, *Serenoa repens*, *Syagrus romanzoffiana*, *S. schizophylla*, *Thrinax parviflora*, *Trachycarpus fortunei*, *T. martiana*, *Veitchia merrillii*, *Wallichia densiflora*, *Washingtonia filifera*, *W. robusta*. The representative palm collections are one of the richest in south-east Asia as palms are useful to the day-to-day life of the people. Most of the palms have rich edible pith. The toddy or wine from palms are important source of drink for the poor people. Some of the palms are "self sacrificers" as they die for their young (Menninger 1972).

WATER LILY COLLECTION

The garden possesses valuable germplasm collection of water lilies distributed in 4 species and 30 varieties. They belong mainly to the family Nymphaeaceae, Nelumbonaceae and Eurayalaceae. The great attraction of the garden during monsoon period (June to October) is the giant Amazon water lilies (*Victoria amazonica*, and *Victoria cruziana*).

BOUGAINVILLEA COLLECTION

The garden is famous for the number of cultivars of Bougainvillea and there are at present 141 cultivars mainly distributed in two species, *Bougainvillea glabra* and *B. spectabilis*. Some of the well known cultivars are "Autumn", "Begum Sikander", "Brilliant variegata", "Dr. B. P. Pal", "Dream girl", "Elizabeth", "Flamboyant", "Golden Glow", "Lady Mary Baring", "Lady Hope", "Lady Mountbatten", "Mary Palmer", "Maharaja of Mysore", "Mahatma Gandhi", "Mary Palmer Special", "Million Dollar", "Princess Margaret Rose", "President Roosevelt", "Summer time", "Spring festival", "Sweet Heart", "Scarlet Glory" and "Wajid Ali Shah".

The garden possesses good orchid collection and cacti collections. Recently a Medicinal Plants garden "Charaka Udhyan" is established near the Central National Herbarium building having about 1000 plants covering 450 species. The garden also possesses good collection of Pandanus, commonly known "screw pines" with stilt roots. Some of the species are *Pandanus furcatus*, *P. leram*, *P. samak* and *P. tectorius*. In the Cycads, the following species are well represented. *Cycas beddomei*, *C. circinalis*, *C. revoluta*, *C. rumphii*. Other well represented cycads are *Encephalartos villosus*, *Zamia angustifolia*, *Z. pallida* and *Z. pumila*.

CONSERVATION AND INDIAN BOTANIC GARDEN

The IUCN conservation programme attaches special importance to the botanic gardens which form a network and there are about 600 botanic gardens throughout the world. Some of the tasks that the gardens should undertake as per IUCN Conservation programme are "(1) Educate the public on why plants are important and why they need conserving, (2) Assess which species are threatened and where and which plant rich sites are most in need of protection by undertaking herbarium studies and field work. Basic research into plant taxonomy and distribu-

tion, as well as economic botany is in itself a vital contribution to conserving habitats, (3) Carry out ecological studies and monitor threatened plants, developing further the disciplines of ecology and population biology, (4) Undertake "gardening" in the habitat of endangered species, if need be bulking up the plants in the garden and reintroducing them; this is essential in saving species reduced to critically low populations, (5) Take responsibility for the conservation of their local flora, if possible by maintaining small species reserves themselves.".

The Botanical Survey of India and the network of experimental gardens under its control is closely connected with the international network of Botanic Gardens and exchange informations on threatened plants. A new scheme on captive breeding of priority-categorised endangered species is under the process of implementation which involves multiplication and reintroduction in the natural habitat. The Las Palmas meeting of Botanic Gardens in 1985 has drawn up an international Botanic Garden Conservation strategy giving thrust to areas how gardens can function as "refugium" for threatened taxa how gardens can function as genetic resource centres, how they can educate the public the importance of taxonomy.

TAXONOMY AND CONSERVATION

Taxonomy and Botanic Gardens are closely connected. Heywood (1985) indicates in a rather forthright way some of the pertinent issues of the day and how taxonomists could play a leading role in the conservation movement. "We must accept our role as custodian of a general biological information systems and devote much more effort to the practical information storage and retrieval side of our business using electronic data processing where appropriate. We must assess the overall situation facing taxonomy today in the light of the world wide threat to plant resources and establish priorities amongst our various activities which take full

Annual Flower Show 1986.

account of the obligations we have to the community from which we ultimately derive our support and finance". Jacobs (1977) strongly pleaded "Taxonomists certainly have to unlearn a lot of indifference to the consumers of their work. Terminology should be more plain English and consistently strived for"

SALIENT FEATURES OF THE GARDEN

The Great Banyan tree which is completing 230 years of its existence is a great draw for the people visiting the Garden. This Banyan tree is mentioned in Guinne's Book of records as one for its great diamensions and number of prop roots. This banyan tree existed on a Phoenix tree before the establishment of the Garden in 1787 and it was reported, a fakir meditated under its shade. In 1925 the main trunk of the tree had to be removed due to fungal attack. However the tree is growing vigorously due to special attention. There are 1825 prop roots and the circumference of the canopy is 420 metres. The area covered by the Great Banyan tree is about 1.40 hectares and the length of highest branch is 24.5 metres. In order to protect the Banyan tree, a strong iron fence was built round the tree recently.

The Great Palm House with rich palm collections and tropical plants represents a miniature tropical forest. Inside the Tropical Palm House it is cool and the temperature inside is 3 to 4°C less than the outside temperature. This gives a great vista of a tropical forest, represented by a mosaic of all plants, tall palms, evergreen trees undergrowths which are shade loving.

The other main events of the Garden are the Annual Flower Show (28 to 30th January) conducted every year and the Vanamahotsava (July) when saplings are distributed at nominal cost. Flower Show was started from the year 1985 onwards and this has attracted large number of plant growers and amateurs. The World Environmental day celebrated on 5th June every year, is a great attraction for children as special arrangements are made for Sit & Draw Competetion of nature and guided tours

The bicentenary of the Indian Botanic Garden is round the corner. A garden which had seen its fortunes and misfortunes in the course of two hundred years of its existence is billed for further growth and development in the coming years. As mentioned earlier that this garden has earned its bread for several generations to come since through this garden, tea, cinchona, rubber and mahogany were established in this country as valuable crops giving rich domestic resources and earning foreign exchange.

Some of the proposals for development have already been sanctioned and they are in the process of implementation

(i) Dome shaped Glass House. This conservatory will be constructed for growing cacti and succulents. The shape of conservatory is octogonal and top will be in the shape of Igloo. It will be constructed on an elevated platform (1.2-1.5 m). The display of specimens can be visible from outside and suitable lighting arrangements will also be provided. The total estimated cost of this conservatory is ten lakhs eightyfour thousand rupees and the amount is sanctioned.

(ii) The Bicentenary Gate with exhibition and briefing rooms will be constructed at the Andul Road inside the Garden. The importance of the Andul Road side would be increased after the construction of the second Howrah bridge as the bypass of the second Howrah bridge approaches near the Andul Road. Once the second Howrah bridge is constructed the Indian

Botanic Garden will be only 15 minutes drive from Calcutta since at present it takes 1 to 2 hours drive depending on the traffic congestion. The briefing room (16 × 10 m) will be constructed adjacent to the Bicentenary Gate where important areas of plant display and plants of interest will be depicted in charts, models and write-ups for the information of the visitors. Some space will be left in front of the Bicentenary Gate for the movement of the visitors avoiding the rush of the main road. On both side of the main gate for the entry of vehicular traffic, there would be small gate for the entry of visitors with turnstile gates. The Bicentenary Gate will be matching with the green surroundings. There will also be provision for reception-cum-sales counter and other amenities for visitors. The estimate of 35 lakhs rupees has been sanctioned for the Bicentenary Gate.

(iii) A proposal for Guest House for scientists and research scholars in the acquired land on the Andul Road near the Botanic Garden is under planning.

(iv) There will be National Garden Festival in January-February, 1988 when the Gardens of India will be invited to exhibit their model of gardens with their plants.

(v) A series of exhibitions and flower shows are planned and saplings from different World Gardens will be planted during the Bicentenary year from 6th July 1987 to 6th July, 1988.

(vi) Special Commemorative Postage stamps will be issued through the Indian Postal authorities.

(vii) Special publication "Network of Botanic Gardens" and "Commemoration Volume of the Bulletin of the Botanical Survey of India" will be published during this period.

It is proposed to allot space for Children Garden for study and a Garden for Handicapped. Wheel chairs will be provided for the Handicapped to see and enjoy the beauty of nature.

Indian Botanic Garden is a botanical garden having landscape beauty and not a horticultural garden of topiaries and fountains. It is neither a garden of artificial lights nor a garden of brick and mortars. Those who have a sense of beauty and landscape appreciation can sit for hours and enjoy the lakes with its panoramic beauty, the stately palms and bamboos. The river Hooghly flowing along the side of the Garden gives one timeless beauty of nature.

REFERENCES

Basu, S. K. & Basu, Sabal. A census of palms cultivated in Indian Botanic Garden, Howrah. Bull. Bot. Surv. India 17 : 32-40. 1975 (1976).

Burkill, I. H. Chapters on the History of Botany in India. 1-245. Botanical Survey of India, Calcutta. 1965.

Chakravarty, H. K. & Mukhopadhyay, D. P. Indian Botanic Garden. Bull. Bot. Surv. India 25 : 290-296. 1983 (1985).

Heywood, V. H. Botanic Gardens and Taxonomy — their taxonomic role. Bull. Bot. Surv. India 25 : 134-147. 1983 (1985).

Hooker, J. D. Himalayan Journal. 1891.

IUCN/WWF. The IUCN/WWF Plant Conservation programme. 1-28. 1984-85.

Jacobs, M. (Editorial). Flora Malesiana Bull. 30 : 2733-2736. 1977.

Menninger, E. A. The self-seeders — they die for their young. Card. Journ. 22 : 166-169. 1972.

Nayar, M. P. & Das, A. P. William Roxburgh (1751-1815) & Nathaniel Wallich (1786-1854). Bull. Bot. Surv. India 25 : 347-356. 1983 (1985).

LIST OF CONTRIBUTORS

Dr. Brian Morley
Director
Botanic Gardens of Adelaide
South Australian Government
Adelaide, Australia

Prof. F. Garbari
Professor of Botany
Pisa University
Pisa, Italy

Ing. W. Ludwig,
Administrator of the
Botanical Collections of the
Austrian Federal Gardens
Vienna, Austria

Dr. D. Bouiter
Director
University of Durham
Botanic Garden
Durham, England.

Dr. S. Ansell
Department of Botany
University of Durham
England

Dr. Jette Bay Mølgr
Curator of the Arboretum
Jardin Botanique
de la' Universite.
Copenhagen, Denmark

Prof. Franz Schotz
Director
Munich Botanical Garden
Bavarian Academy of Sciences
Munich

Prof. Josef Bogner
Munich Botanical Garden
Bavarian Academy of Sciences
Munich

Prof. Kazimierz Szczepanek
Institute of Botany
Botanic Garden
Jagellonian University
31-501, Krakow,
Kopernika 27, Poland

Prof. Dr. Hartmut Ern
Director of Botanischer
Garden und Botanisches Museum
Berlin Dahlem, Kaenigin
Luise-Strasse 6-8, D-1000
Berlin 33

Jakub Dolatowsk
Director
Institute of Dendrology
Polish Academy of Sciences
Poland

Prof. Bernese Oberland
Alpine Botanical Garden
3800, Interlaken
Switzerland

Dr. W.O. Gigor
Alpine Botanical Garden
3800, Interlaken
Switzerland

P. J. Maudsley
Director
Royal Horticultural Society's Garden,
Wisley, U.K.

Dr. Gordon L. Tarbox, Jr.
Director
Brookegreen Gardens,
A Society for South
Eastern Flora & Fauna
Murrells Inlet
Southern Carolina
29576 (803) 203-4218, USA.

Dr. Robin Salmon
Archivist of the Brookgreen Gardens
A Society for South-Eastern
Flora & Fauna
Murrels Inlet Southern
Carolina. 29576 (803)
203-4218, USA.

Prof. L. N. Andreev
Director of the
Main Botanical Garden
USSR Academy of Sciences
Moscow, USSR.

Dr. Erik A. Neumann
Curator of Education
United States National
Arboretum, 3501, New York
Avenue, N.E. Washington DC
20002, USA

Dr. M. A. Proskuryakov
Director of the Main
Botanical Garden of
the Kazakh SSR Academy
of Sciences, USSR.

Prof. R. Cinovskis
Professor of the Laboratory
of Dendroflora of the Botanical
Garden of the Academy of Sciences
of the Latvian SSR, USSR.

Prof. E. W. Curtis
Curator of Botanic Gardens
University of Glasgow
Glasgow, Scotland.

Prof. E. V. Kutcherov
Professor USSR Academy of
Sciences, Bashkirian Branch
Institute of Biology
Ufa-450054, USSR.

Prof. Chen-Zi-Tang
Director
South East China Botanic Garden
Academia Sinica,
Guangzho (Canton)
China.

Dr. A. M. Grodzinsky
Director of Central
Republic Botanical Garden
of the Ukraine
USSR, Kiev 14, USSR.

Prof. F. Ebel
Martin Luther University
Halle-Wittenberg Halle
German Democratic Republic.

Dr. S. Rauschert
Martin-Luther University
Halle Wittenberg Halle
German Democratic Republic

Dr. E. Weinert
Martin-Luther University
Halle Wittenberg Halle, G.D.R.

Prof. Dr. Gerhard Gottsberger
Director of Botanisches
Institut und Botanischer
Garten, Universitat Giessen
6300 Giessen
Federal Republic of Germany

Dr. P. R. Wycherley
Director
Kings Park and Botanic Garden
W. Perth, Western Australia
Australia

Dr. A. P. Paterson
Director of Royal Botanical Gardens
P.O. Box. 399
Hamilton, Ontario
Canada

Prof. Xu Zaitu
Associate Professor &
Director of Xishuangbanna
Botanical Garden of Tropical
Plants
Vice Director, Yunnan Institute
of Tropical Botany, Chinese
Academy of Sciences, Mengla
Yunnan, China

Prof. M. A. Gogolishvili
Director
Central Botanical Garden
Academy of Sciences of Georgian SSR,
Botanischeskaya
Str. 1 38005, Tbilisi,
Georgia, USSR

Prof. A Abraham
Chairman
Governing Body of the
Tropical Botanic Garden &
Research Institute
P.B. No. 2415
Navaranga Road
Trivandrum-695011, India

Dr. D. B. Sumithraarachchy
Deputy Director of Agriculture
(Botanic Gardens)
Royal Botanic Garden
Peradeniya, Sri Lanka

Dr. Gulkam T. Prance
Senior Vice President for Science
The New York Botanical Garden
Bronx, New York-10458-9980, USA

Prof. J. E. Hernandez Bermejo
Director, Del Jardin
Botanico de Cordoba
Spain

Dra M. Clemente Munoz
Del Jardin
Botanico de Cordoba
Spain

Dr. C. C. Wilcock
Curator
Cruickshank Botanic Garden
Department of Plant Science
University of Aberdeen
St. Machar Drive, Aberdeen
AB9, 2UD, United Kingdom

Prof. Kai Larsen
Professor of Botany
Botanisk Institute Aarhus
University Nordlandsvej 68,
DK-8240, Risskov
Denmark

Dr. Ivan Nielsen
Botanisk Institute Aarhus University
Nordlandsvej 68,
DK 8240, Risskov, Denmark

Dr. M. P. Nayar
Director
Botanical Survey of India
P8 Brabourne Road
Calcutta-700001. India

Dr. R. K. Chakraverty
Scientist 'D'
Indian Botanic Garden
Botanical Survey of India
Howrah-711003. India