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History of Botanical Research in India

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ABSTRACT: The Botanical Survey of India (BSI) was established in 1890 with the objectives of exploring the plant resources of the country and identifying plant species with economic virtue. In 1954, the Government reorganised the BSI with the objectives of (1) undertaking intensive floristic surveys and collecting accurate and detailed information on the occurrence, distribution, ecology and economic utility of plants in the country; (2) collecting, identifying and distributing materials that may be of use to educational and research institutions; and (3) acting as the custodian of authentic collections in well planned herbaria and documenting plant resources in the form of local, district, state and national flora. India has diverse geographical features, including the lofty Himalayan mountains, the tablelands and plateaus in the Vindhyan ranges and the Western and Eastern Ghats, the deep valleys and foothills of Assam, the central Indian highlands, the alluvial plains of north India and the lower terrain of southern India. As a result, the Indian region exhibits a variety of flora and forest types. There is perhaps nothing similar in any other country of the world. Since ancient times, the vegetable resources of India have attracted the attention of traders from both within and outside the region. The trade with India based on plants and other forest produce grew over time, attracting Arab, Turkish, Portuguese, Dutch, French and finally British traders. The Portuguese were probably the first amongst the Europeans to enter India for trade, and they were followed by the Dutch. In 1570 the British entered the arena and subsequently established the East India Company.

KEYWORDS: Botanical, research, survey, India, Himalayan, alluvial, trade, institutions, educational

I. INTRODUCTION

Botanical Survey of India (BSI) located in Kolkata, West Bengal, India. It was founded on 13 February 1890, is Government of India Ministry of Environment, Forest and Climate Change's organization for survey, research and conservation of plant wealth of India, flora and endangered species of India, including by collecting and maintaining germplasm and gene bank of endangered, patent and vulnerable plant species.[1,2]

In 1599, Elizabeth I of England granted the company a charter, and subsequently the British traders became rulers. They gave priority to discreet utilisation and scientific management of the forest wealth of India and set out definite policies. And the idea of an institution for surveying the tremendous botanical resources of the country was conceived. Towards the latter part of the 16th century, live and 'dry and preserved'[3,4] gardens were developed in north Italy for teaching medicine because of the medicinal uses of plants. The dry gardens consisted of dried and mounted specimens maintained in a definite sequence, and they were used as aids for teaching plant science. Soon medical professionals extended such activities[5,6] to places outside Italy. Even before the formation of the East India Company, similar botanical pursuits were carried on in India. The Portuguese were the first to pay attention to the useful plants of India. Garcia de Orta, a renowned Portuguese physician who came to India in 1534, studied plants from which drugs are obtained and other species of economic importance, growing them in his garden at Goa. He contributed much to the study of the plant resources of India. To the plant species that were locally used and traded, he introduced several.[7,8] Hendrik van Rheede, governor of the Dutch settlement in the Malabar, devoted himself to studying and collecting the plants of this region in the 17th century. He inspired local medical men to collect data and specimens of medicinal plants. He accumulated a vast treasure of dried and mounted specimens from various places in southern India. His monumental work, Hortus Malabaricus (1678 – 1703), in 12 volumes with 794 plates, has the distinction of being the first work on the systematics of Indian plants. [9,10] Linnaeus himself declared that it was accurate. The East India Company, which had its own physicians and surgeons, engaged them in the collection of plants from Madras to cultivate in Britain. Interest in botanical collections grew further in the 18th century, and different agencies became active in exploring all parts of India, as well as Assam and Burma, for plants. Members of the clergy, medical



professionals and servants of the East India Company were all actively engaged in searching different forested areas for plant material. Koenig, Roxburgh, Hayne, Wight, Campbell, Thunberg, Buchanan and Wallich were among the principal contributors. The collections made by some of them were sent to Linnaeus, Sir Joseph Banks, Hooker and others.[11,12]

Along with botanical studies, horticulture gained importance. New botanical gardens were set up for introducing and cultivating exotic species. The East India Company established a garden at Sibpur, Calcutta in 1787, following the recommendations of Colonel Robert Kyd. This garden was known as the Company Bagan. Similarly, gardens were established at Bombay, Saharanpur, Madras and other centres. Each garden had its own herbarium, with dried specimens for reference. During this period, plant taxonomy emerged as an indispensable instrument in the study of medicine, horticultural practices, forest utilisation and conservation. Achievements in the study of plants were mainly due to the efforts of individuals rather than any central authority or institution. In 1858, when the Crown of England took over the affairs of the East India Company, the garden at Sibpur was renamed the Royal Botanic Garden.[13,14] An effort was made to form a central survey for coordinating activities related to the flora of the country. By the end of the 19th century, botanical studies were conducted by the governments of the Bengal, Bombay and Madras presidencies and the North-Western Provinces through their botanical departments in the gardens at Sibpur, Poona, Madras and Saharanpur. Brigade Surgeon Lieutenant Colonel Sir George King, who took charge of the Royal Botanic Garden, Calcutta in 1871 was instrumental in getting a new building built for the herbarium in 1882. All the books and about half a million plant specimens were transferred to the new building in the following year. By the time Sir George King left the Botanic Garden in 1897, the number of herbarium specimens had risen to a million.[15,16]

At that time, the Government of India was preparing to explore the frontier and trans-frontier regions in north-west Punjab, the Central Provinces, central India, Rajputana, Assam, Burma and the Andamans. The time was right for setting up a central organisation by pooling the available resources to coordinate the botanical work. A proposal for organising a survey was put forth before the government, and in July 1887 the Secretary of State for India approved it. On 13 February 1890, a survey was formally constituted and designated as the Botanical Survey of India.[17,18]

Botanical Survey of India also offers Fellowship for doing research in Plant Taxonomy and also offers post doctorate fellowships to those who are trained in Taxonomy and want to continue their research related to the mandate of BSI.[19,20]

Apart from the Publishing Flora of India series books, states floras, flora of Protected regions and Red Data Book of Indian Plants, BSI have also known for its various annual publications some of them are:

Plant Discoveries: Plant Discoveries is an annual bilingual publication of Botanical Survey of India, having most authentic information on India's plant wealth. As per recent release of Plant Discoveries 2019 by Botanical Survey of India, there is total of 18800 species of angiosperms, 82 species of gymnosperms, 1307 species of pteridophytes, 15447 species of fungi, 7434 species of algae, 2786 species of bryophytes, 2981 species of lichens and 1239 species of microbes in India, which is approximately 8 percent of total recorded plant species in world. Since its reorganization, in 1954, BSI officials described 01 new families, 42 new genus and 1719 new species and infra-specific taxon. During 2019, total 253 plants has been discovered by scientist of BSI and other institutes. Nelumbo is a biannual journal published by the Botanical Survey of India. The journal is peer-reviewed and authentic journal of plant taxonomy and plant sciences. As per recent NAAS rating 2019 the journal rated 4.17. [21,22]

According to the Botanical Survey of India, India is currently having 8000 species of medicinal plants. Therefore the ministry of Ayush provides financial support in the form of Subsidies, for the cultivation of various medicinal plants and the species which are required by AYUSH systems and also to take care of other plants which are on the verge of extinction.

II. DISCUSSION

The present CSIR-National Botanical Research Institute owes its origin to the era of Nawabs of Oudh when Nawab Saadat Ali Khan established a royal garden in 1800 A.D. Later, Nawab Wajid Ali Shah, the last Nawab of Oudh, dedicated this royal garden to one of his favourite queens, Sikander Mahal Begum, and christened this garden as



“Sikandar Bagh”. During British rule, Sikander Bagh became an active centre of horticultural activities and was known as the ‘Government Horticultural Garden’. Famous British horticulturists, namely, Dr. J. Cameron, Dr. E. Bonavia, G.M. Ridley, have been associated with the activities of this garden.

During 1932, and in the following years, Prof. Birbal Sahni and Dr. S.K. Mukherjee, both renowned plant scientists, transformed this horticulture garden to a botanic garden by acquiring additional land from Government for the cultivation and study of medicinal plants. Later the Botanic Garden was rechristened as ‘National Botanic Gardens’ [23,24]

Realising its potential, the National Botanic Gardens (NBG) was later adopted by Council and Industrial Research on April 13, 1953. Prof. K.N. Kaul was appointed as its first regular director. Since 1953, CSIR has been providing financial and various other supports for the development of NBG into a national institute for plant science research. The transformation of NBG into a present day hi-tech research institute with state-of-the-art facilities makes it capable of undertaking advanced research at globally competitive levels. Later in the year 1978, “National Botanic Gardens’ was renamed as National Botanical Research Institute.

The history of botany examines the human effort to understand life on Earth by tracing the historical development of the discipline of botany—that part of natural science dealing with organisms traditionally treated as plants.[25,26]

Rudimentary botanical science began with empirically-based plant lore passed from generation to generation in the oral traditions of paleolithic hunter-gatherers. The first written records of plants were made in the Neolithic Revolution about 10,000 years ago as writing was developed in the settled agricultural communities where plants and animals were first domesticated. The first writings that show human curiosity about plants themselves, rather than the uses that could be made of them, appear in ancient Greece and ancient India. In Ancient Greece, the teachings of Aristotle's student Theophrastus at the Lyceum in ancient Athens in about 350 BC are considered the starting point for Western botany. In ancient India, the *Vṛkṣāyurvēda*, attributed to Parāśara, is also considered one of the earliest texts to describe various branches of botany.

In Europe, botanical science was soon overshadowed by a medieval preoccupation with the medicinal properties of plants that lasted more than 1000 years. During this time, the medicinal works of classical antiquity were reproduced in manuscripts and books called herbals. In China and the Arab world, the Greco-Roman work on medicinal plants was preserved and extended.[27,28]

In Europe the Renaissance of the 14th–17th centuries heralded a scientific revival during which botany gradually emerged from natural history as an independent science, distinct from medicine and agriculture. Herbals were replaced by floras: books that described the native plants of local regions. The invention of the microscope stimulated the study of plant anatomy, and the first carefully designed experiments in plant physiology were performed. With the expansion of trade and exploration beyond Europe, the many new plants being discovered were subjected to an increasingly rigorous process of naming, description, and classification.

Progressively more sophisticated scientific technology has aided the development of contemporary botanical offshoots in the plant sciences, ranging from the applied fields of economic botany (notably agriculture, horticulture and forestry), to the detailed examination of the structure and function of plants and their interaction with the environment over many scales from the large-scale global significance of vegetation and plant communities (biogeography and ecology) through to the small scale of subjects like cell theory, molecular biology and plant biochemistry.[29,30]

Botany (Greek *Βοτάνη* - grass, fodder; Medieval Latin *botanicus* – herb, plant) and zoology are, historically, the core disciplines of biology whose history is closely associated with the natural sciences chemistry, physics and geology. A distinction can be made between botanical science in a pure sense, as the study of plants themselves, and botany as applied science, which studies the human use of plants. Early natural history divided pure botany into three main streams morphology-classification, anatomy and physiology – that is, external form, internal structure, and functional operation. The most obvious topics in applied botany are horticulture, forestry and agriculture although there are many others like weed science, plant pathology, floristry, pharmacognosy, economic botany and ethnobotany which lie outside modern courses in botany. Since the origin of botanical science there has been a progressive increase in the scope of the subject as technology has opened up new techniques and areas of study. Modern molecular systematics, for example, entails the principles and techniques of taxonomy, molecular biology, computer science and more.



Within botany there are a number of sub-disciplines that focus on particular plant groups, each with their own range of related studies (anatomy, morphology etc.). Included here are: phycology (algae), pteridology (ferns), bryology (mosses and liverworts) and palaeobotany (fossil plants) and their histories are treated elsewhere (see side bar). To this list can be added mycology, the study of fungi, which were once treated as plants, but are now ranked as a unique kingdom.

Nomadic hunter-gatherer societies passed on, by oral tradition, what they knew (their empirical observations) about the different kinds of plants that they used for food, shelter, poisons, medicines, for ceremonies and rituals etc. The uses of plants by these pre-literate societies influenced the way the plants were named and classified—their uses were embedded in folk-taxonomies, the way they were grouped according to use in everyday communication. The nomadic life-style was drastically changed when settled communities were established in about twelve centres around the world during the Neolithic Revolution which extended from about 10,000 to 2500 years ago depending on the region. With these communities came the development of the technology and skills needed for the domestication of plants and animals and the emergence of the written word provided evidence for the passing of systematic knowledge and culture from one generation to the next.[31]

During the Neolithic Revolution plant knowledge increased most obviously through the use of plants for food and medicine. All of today's staple foods were domesticated in prehistoric times as a gradual process of selection of higher-yielding varieties took place, possibly unknowingly, over hundreds to thousands of years. Legumes were cultivated on all continents but cereals made up most of the regular diet: rice in East Asia, wheat and barley in the Middle east, and maize in Central and South America. By Greco-Roman times popular food plants of today, including grapes, apples, figs, and olives, were being listed as named varieties in early manuscripts. Botanical authority William Stearn has observed that "cultivated plants are mankind's most vital and precious heritage from remote antiquity".

It is also from the Neolithic, in about 3000 BC, that we glimpse the first known illustrations of plants and read descriptions of impressive gardens in Egypt. However protobotany, the first pre-scientific written record of plants, did not begin with food; it was born out of the medicinal literature of Egypt, China, Mesopotamia and India. Botanical historian Alan Morton notes that agriculture was the occupation of the poor and uneducated, while medicine was the realm of socially influential shamans, priests, apothecaries, magicians and physicians, who were more likely to record their knowledge for posterity. [32,33]

An early example of ancient Indian plant classification is found in the Rigveda, a collection of Vedic Sanskrit hymns from about 3700–3100 BP. Plants are divided into *vr̥ska* (trees), *osadhi* (herbs useful to humans) and *virudha* (creepers), with further subdivisions. The sacred Hindu text Atharvaveda divides plants into eight classes: *visakha* (spreading branches), *manjari* (leaves with long clusters *sthambini* (bushy plants), *prastanavati* (which expands); *ekasṛnga* (those with monopodial growth), *pratanavati* (creeping plants), *amsumati* (with many stalks), and *kandini* (plants with knotty joints). The Taittiriya Samhita classifies the plant kingdom into *vr̥ksa*, *vana* and *druma* (trees), *visakha* (shrubs with spreading branches), *sasa* (herbs), *amsumali* (spreading plant), *vratati* (climber), *stambini* (bushy plant), *pratanavati* (creeper), and *alasala* (spreading on the ground). Other examples of early Indian taxonomy include Manusmriti, the Law book of Hindus, which classifies plants into eight major categories. Elaborate taxonomies also occur in the Charaka Samhitā, Sushruta Samhita and Vaisesika

In ancient China lists of different plants and herb concoctions for pharmaceutical purposes date back to at least the time of the Warring States (481 BC-221 BC). Many Chinese writers over the centuries contributed to the written knowledge of herbal pharmaceuticals. The Han Dynasty (202 BC-220 AD) includes the notable work of the Huangdi Neijing and the famous pharmacologist Zhang Zhongjing. There were also the 11th century scientists and statesmen Su Song and Shen Kuo who compiled learned treatises on natural history, emphasising herbal medicine[34]

III. RESULTS

A botanical garden, also called a botanic garden, is a garden that contains a wide variety of plant species, usually labelled with their scientific names. A botanical garden is typically devoted to research, cultivation, preservation, and display of plants.



As one of the world's mega-biodiversity countries, India has a wide variety of plant species. India has one of the richest floras in the world, thanks to its sheer size, range of latitudes and altitudes, rainfall, and climatic and geographical conditions.

There are about 200,000 living plants recorded in the accessions of these gardens.

Acharya Jagadish Chandra Bose Botanic Garden in Kolkata is the first botanical garden established in India and also in South Asia.

The first botanical garden of India was founded in 1787 by an army officer of the East India Company, named Colonel Robert Kyd. The primary purpose of establishing the garden was to identify new plant species, such as teak, which had great economic value and grow them on a commercial scale for trade.

It was then named Royal Botanic Garden, Calcutta. Later, the name was changed to Calcutta Botanical Garden and then to Indian Botanic Garden. On 25th June 2009, the name was finally changed to Acharya Jagadish Chandra Bose Botanic Garden in honour of Acharya Jagadish Chandra Bose, a Bengali botanist-physicist and an early writer of science fiction.

Over 12,000 specimens of rare plants are housed in the garden, which cover 109 hectares. Under the Ministry of Environment and Forests of India, the Botanical Survey of India (BSI) manages the centre.[35]

As botanical gardens house a wide variety of plant species, it is an open, outdoor laboratory for a large number of students and botanists. Such a garden is important because:

- It is a place where a variety of endangered flora are conserved.
- It helps in taxonomic study and research.
- It provides the public with information about local and exotic species of plants.
- Rare species and genetic diversity are conserved and propagated in a botanical garden.

There are about 122 botanical gardens recorded in India. Below is the list of the famous botanical gardens in India:

- Assam State Zoo-cum-Botanical Garden– Guwahati, Assam
- Botanical Garden Sarangpur – Chandigarh
- Sanjay Gandhi Jaivik Udyan – Patna, Bihar
- Botanical Garden Waghai – Gujarat
- Gujarat Technological University – Ahmedabad, Gujarat
- R. B. Botanical Garden and Amusement Park – Gujarat
- The Garça Branca Ayurvedic Botanical Garden – Loutolim, Goa
- National Cactus and Succulent Botanical Garden and Research Centre – Haryana
- Lalbagh – Bangalore, Karnataka
- Curzon Park – Mysore, Karnataka
- Mysore Zoo – Mysore, Karnataka
- Pilikula Arboretum, Pilikula Nisargadhama – Mangalore, Karnataka
- Regional Museum of Natural History Mysore – Mysore, Karnataka
- University of Mysore Botanic Garden – Mysore, Karnataka
- Prof. Nagaraj Botanical Garden – Kalaburgi, Karnataka
- Malabar Botanical Garden and Institute of Plant Sciences – Kozhikode, Kerala
- Malampuzha Garden – Palakkad, Kerala
- Jawaharlal Nehru Tropical Botanic Garden and Research Institute – Trivandrum, Kerala
- Vellayani Agricultural College – Trivandrum, Kerala
- Empress Garden – Pune, Maharashtra



- Odisha State Botanical Garden – Nandankanan, Bhubaneswar, Odisha
- Botanical Garden Guru Nanak Dev University – Amritsar, Punjab
- Botanical Garden Punjabi University – Patiala, Punjab
- Auroville Botanical Gardens – Auroville, Tamil Nadu
- Tamil Nadu Agricultural University – Coimbatore, Tamil Nadu
- The Institute of Forest Genetics and Tree Breeding – Coimbatore, Tamil Nadu
- Government Botanical Gardens, Ootacamund – Nilgiris, Tamil Nadu
- Semmozhi Poonga – Chennai, Tamil Nadu
- Botanical Garden, Hyderabad – Telangana
- NTR Garden – Hyderabad, Telangana
- Botanical Garden of India Republic – Noida, Uttar Pradesh.
- Jhansi Botanical Garden – Jhansi, Uttar Pradesh
- Saharanpur Botanical Garden – Uttar Pradesh
- Acharya Jagadish Chandra Bose Indian Botanic Garden – Shibpur, Kolkata, West Bengal
- Agri Horticultural Society of India – Alipore, Kolkata, West Bengal
- Garden of Medicinal Plants, North Bengal University – West Bengal
- Lloyd's Botanical Garden – Darjeeling, West Bengal
- Narendra Narayan Park – Cooch Behar, West Bengal

Some interesting facts about the famous botanical gardens in India:

1. Largest and first botanical garden in India – Acharya Jagadish Chandra Bose Indian Botanic Garden
2. Oldest botanical garden in India – Acharya Jagadish Chandra Bose Indian Botanic Garden
3. Kohli Memorial Himalayan Garden – operated as the world's smallest botanical garden for 20 years from 1990
4. Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Trivandrum, Kerala, conserves the largest number of plant species in Asia.
5. An amazing collection of roses can be found at the Government Botanical Garden in Udumalpet in Tamil Nadu.
6. National Cactus and Succulent Botanical Garden and Research Centre – one of the largest cactus and succulent botanical gardens in India
7. The largest collection of aquatic plant species in India – Malabar Botanical Garden and Institute of Plant Sciences

Dedicated to preserving and exhibiting different species of plants and trees, botanical gardens are specialised exhibit sites. A botanical garden's purpose is to conduct education and research through the use of libraries, herbaria, laboratories, and museums.

As organisations dedicated to horticulture and botany, botanical gardens have developed over time. Today, most botanical gardens encompass different themes and try to keep in touch with local concerns. There must be a balance between the need for privacy and seclusion in botanical gardens and welcoming and providing accurate information to visitors.

IV. CONCLUSIONS

The National Botanical Research Institute has a rather chequered history of two centuries. Its origins around the year 1800 A.D. in the city of Lucknow as a pleasure garden under feudal rulers of the day (Nawabs of Awadh) is a testimony to this. It was also the scene of major hostilities during the Sepoy Mutiny of 1857. The European rulers took control of the Indian subcontinent with the end of the mutiny in 1858, and thus began a fresh saga of scientific approach to the development and maintenance of the garden.



It was declared a Govt Horticultural Garden, a plant nursery and several fruit orchards were added. Exchange of exotic plants with other botanical institutions became a regular practice. An Agri-Horticultural Society was setup which organized regular flower shows and plant exhibitions. A number of people who supervised the working of the gardens during this period and acted as Superintendents were acclaimed botanists and plant scientists, notable amongst them were Dr Bonavia and Dr Cameron who wrote authoritative research papers and monographs on citrus plantations.

It was in the year 1953 that the garden was absorbed as an umbrella organization by CSIR (Council of Scientific and Industrial Research) and renamed as the National Botanic Garden. The scope of its functions has magnified exponentially ever since. It has been involved in the area of plant science research wholeheartedly and much of its effort has been directed in the area of

- exploration of plant species (also done by Botanical Survey of India but on a geographical /spatial basis)
- taxonomic studies.
- propagation of plants of ornamental and economic value.
- conservation and protection of valuable plant species.
- genetic studies and experimentation.

It was renamed as the National Botanical Research Institute in October, 1978, which appropriately reflected its changed status.

Botanical Survey of India (BSI) and Natural History Museum (NHM), UK signed a Memorandum of Understanding for cooperation in the field of genetic/taxonomic studies, research and training, conservation in India, including species and habitat conservation assessments, etc here today.

The MoU was signed by Director, BSI Dr Paramjit Singh and Head of the Algae, Fungi and Plants Division, NHM, Dr Sandra Knapp, in the presence of Union Minister for Environment, Forest & Climate Change, Dr Harsh Vardhan.[34,35]

The MoU will pave the way for BSI staff to work in Natural History Museum, London and vice-versa and they will share fairly and equitably the benefits that may arise from the collection, study and conservation of the plant materials such as seeds, herbarium specimens and tissue samples and exchange associated data and images. NHM will help BSI in capacity building in areas of systematic botany and long-term conservation of plant genetic resources in India.

Botanical research has a long history in India, and modern scientific institutions have developed over two centuries. The collection of Indian plants held in UK institutions, together with India's own tremendous collections, are an invaluable resource for modern Indian botanical science. Collections, digitisation and study by Indian scientists will make these openly available for wider scientific use in India in areas such as biodiversity conservation, environmental protection, and preservation of plant resources for use in traditional health systems by rural communities.

Lakhs of herbarium specimens of Indian plants are located in the Natural History Museum in London, and a renewed partnership with the Botanical Survey of India is creating digital images of these specimens to make them available to Indian science. Three staff members of BSI have received Rutherford Fellowships (funded by the UK government's Department for Business, Energy and Industrial Strategy - BEIS) to undertake this important work in London. They have received training in all aspects of digitisation and herbarium curation, and have already imaged some 16,000 sheets in plant families that are essential to crop science and food security. At the same time two botanists from NHM are working in BSI herbaria throughout the country, identifying specimens, capacity building, interacting with young Indian taxonomists and exchanging ideas.

This open science and collaboration is a core goal of both Botanical Survey of India and Natural History Museum, signing of the Memorandum of Understanding between BSI and NHM is set to develop further to the benefit of both India and the UK. Both countries are committed to the use of scientific evidence to support the goals of the Convention



on Biological Diversity, CITES and the Nagoya Protocol – this MOU will enable research that will underpin these national responsibilities.

Capacity building and scientific exchange between India and the UK will also be central to future work under the Memorandum of Understanding and will enable learning from each other and work collaboratively to address important scientific questions and deliver benefit to humanity.[36]

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