

## PLANT TAXONOMY—ITS PAST ROLE AND FUTURE LINES OF ACTION IN INDIA

K. SUBRAMANYAM AND M. P. NAYAR

*Botanical Survey of India, Calcutta*

## ABSTRACT

The history of floristic and taxonomic research in India is briefly reviewed and the decline and revival of floristic studies in India is traced.

Modern concepts in plant taxonomy are towards the synthesis of orthodox taxonomic practices and modern methodologies. There need not be any clash between the so called alpha and omega taxonomists. All data that can be readily scanned for the species is useful for the taxonomist. The only aspect that has to be considered is the utility of classification for a specified purpose. A field, or forest botanist needs diagnostic keys based on superficial morphological characters for identification of plants in the field. Characters based on anatomy, embryology, chromosome structure and number, palynology, plant alkaloids and protein serum analysis are useful tools for finding out the systematic position of plants of doubtful affinity; however, these characters cannot be readily used in the field for identification of plants. The herbarium identification of plants is the simple method of retrieval of plant identity through standard specimens properly authenticated by an expert. It does not give legality for the concept of fixity of species as wrongly alluded to by some non-taxonomists, since Nomenclatural Type is a constituent element of a taxon and it is not necessarily the most representative element.

Some of the lines where taxonomists could play a major role are the inventory listing of plants for the conservation of species, monitoring rate of decline and spread of species, establishment of botanical record centres, environmental education and collaboration with universities for reorientation of teaching methods.

The necessity for floristic training is stressed and a syllabus drawn up.

## INTRODUCTION

The history of floristic and taxonomic research in India up to 1900, as elsewhere, is synonymous with the history of botanical studies. New disciplines in Botany like cytology, genetics, physiology, anatomy, palynology were in its infancy at the beginning of this century and there was a great spurt of activities in the collection of plants, description of new species and writing floras. The history of plant exploration in India closely follows the colonisation and expansion of British Empire in India as rightly pointed out by Burkill (1965) in the Chapters on the History of Botany in India. The Surgeons of East India Company's Medical Service, directed their energy to botanical pursuits and they developed gardens of medicinal plants and nurseries for the economic utilisation of the plant products of the Empire. Missionaries also contributed to this study during their spare time. As complementary to botanic gardens, dried plants with annotated information were assembled for ready identification of plants. Agricultural research in an organised manner was still in its infancy and everything connected with plants were dealt with mainly from the morphological and classificatory angle, based on inductive generalisations. In natural history inductive generalisations cannot be based on a single experiment, but by a large number of supporting evidences from allied disciplines of study. At that time modern tools of experimenta-

tion were not available to the biologist for testing the inductive processes of natural history. In such a background, the Department of the Botanical Survey of India came into existence in the year 1890, with four centres at Calcutta (Shibpur), Saharanpur, Bombay (Poona) and Madras. With the development of Agriculture Departments in the Provinces, the fundamental side of plant classification and service side of plant identifications were left to this Department. Even the financial provision for housekeeping and maintenance of valuable specimens in the herbaria were not readily available. Sen Gupta (1959) in his paper entitled "Botanical Survey of India. The past, present and future" gave historical details of the decline of the Botanical Survey of India and its revival since 1954.

With the non-functioning of the Botanical Survey of India, there was decline in the study of floristics and systematics in the Universities. There was great glamour among students for new fields of Botany like cytology, genetics and physiology since experimentation found full satisfaction to the new generation of botanists with an anti-inductive bias. Plant systematics was considered by teachers and taught as a dead subject limited to the study of "bits of hay, stuck on herbarium sheets and pigeonholed in cupboards". Students shunned the subject of systematics as they thought they were specialising in an out-of-date subject. Besides, there were no career prospects in systematics for attracting students. The

period between 1925 and 1955 was a period of stagnation for floristic and taxonomic studies in India. Barring pockets of some active taxonomic schools at the Indian Botanic Garden and few Universities there was no systematic attempt to study the flora of India. Since there were only a few taxonomists in the country, Indian plants had to be sent to foreign herbaria, for their authentic identification. With the revival of the Botanical Survey of India, this trend was reversed and during the last 15 years a group of Systematists have been trained for the identification of plants of India, though much headway has not been made in the taxonomy of lower groups particularly the algae and the fungi.

Sen Gupta (1959) gave a detailed account of the plan and programme of the Botanical Survey. We may recapitulate some of the salient features of the plan since it forms the basis for future lines of action. In order to give impetus to the study of floristics and systematics in the country, as a first step, the Herbaria of certain State Governments were taken over by this Department: Gamble's Madras Herbarium from the Madras Government; the Economic Botanist's Herbarium at Poona from the Bombay Government; the Forest Herbarium at Shillong from the Assam Government; and the Calcutta Herbarium at Shibpur from the West Bengal Government. Besides, for proper identification of plants, out-of-print provincial floras, like Gamble's Flora of the Madras Presidency, Cooke's Flora of the Bombay Presidency, Duthie's Flora of the Upper Gangetic Plain, Haine's Botany of Bihar and Orissa and Prain's Bengal Plants were reprinted by the Botanical Survey of India and released for sale at a subsidised price. Planned plant surveys were conducted in explored and underexplored regions of the country by the different units of the Botanical Survey and an up-to-date map has been circulated to the botany departments of the various Universities and other scientific institutions in India. The Bulletin of the Botanical Survey of India, a quarterly journal, was initiated as a first step for early publication of new taxa and other findings and this priced publication is sent to the Universities free of cost. Research Scholarships for floristic studies have been initiated for training students in floristics. The Indian Botanic Garden at Shibpur was transferred to the Central Government from the West Bengal Government in order to develop this historical garden as a model garden for research in Asia. Since this country is rich in orchids, National

Orchidaria have been established at Shillong, and Yercaud (Madras State). Three Experimental Gardens in different climatic regions (Poona, Shillong and Yercaud) have been started under the three Regional Circles of the Botanical Survey of India. One at Pauri (U.P.) under the Northern Circle is expected to be started soon. As a part of the Fourth Five Year Plan, two new circles, the Arid Zone Circle and the Andaman Circle have been established at Jodhpur and Port Blair respectively. Recently, the Botanical Survey of India at the Central National Herbarium has chalked out a programme for the preparation of the Flora of India. Since the compilation of the Flora of British India by Hooker (1872-97), additional information has accumulated and more novelties added to the Indian flora. After the reorganisation of the Botanical Survey of India in 1954, by systematic surveys plants have been collected from unexplored and underexplored regions of the country and the necessary infrastructure has been built up for this project. This treatise will serve as an identification manual containing dichotomous keys, diagnoses, habitat, distribution summaries, pertinent synonymy and other useful information.

#### EVOLUTION OF MODERN TAXONOMY

The saying "God made the species, all else is the work of man" is an attitude based on pre-Darwinian concept which is an antithesis of evolution. Modern concepts in plant taxonomy are towards the synthesis of orthodox taxonomic practices and modern methodologies. There need not be any clash between the so called alpha and omega taxonomists. All data that can be readily scanned for the species is useful for the taxonomist. The only aspect that has to be considered is the utility of classification for a specified purpose. A field or forest botanist needs diagnostic keys based on superficial morphological characters for identification of plants in the field. Characters based on anatomy, embryology, chromosome structure and number, palynology, plant alkaloids, protein serum analysis are ideal for finding out the systematic position of plants of doubtful affinity; however, these characters cannot be readily used in the field for identification of plants. The herbarium identification of plants is the simple method of retrieval of plant identity through standard specimens properly authenticated by an expert. It does not give legality for the concept of fixity of species as wrongly alluded to by some non-

taxonomists, since Nomenclatural Type is a constituent element of a taxon and it is not necessarily the most representative element.

There is an increasing awareness that the value of classification enhances proportionately to the number of characters used and catholicity of outlook is the soul of a good taxonomist since classification is mainly a cumulative subject. Numerical Taxonomy has already made a mark in solving some taxonomic problems.

*The conservation of species:* Including all living organisms known and unknown by the current standards, there may be about 10 million species of organisms in the world, of which we have in the past 220 years, described about 15%. For more than 95% of the described species we know nothing more than a few morphological facts. Tinker (1971) reports that "twenty-thousand plant species in danger of extinction. The essential preliminary to any conservation programme is a precise catalogue of what these species are, but so far only 68 are listed in IUCN's Red Data Book." In India, according to a conservative estimate there are about 14000 known described species of flowering plants distributed over 2,252 genera and over 304 families. This represents only 6% of known flowering plants of the world (i.e. 250,000 species) and this is supported on a land area of 3,290,054 sq. km. Comparing the floristic areas of Malesia and Brazil, taxa per sq. meter in India is comparatively less. In India, the great mountain chains of Himalayas, Western Ghats, Vindhyas and Satpura Ranges, Eastern Ghats, Khasi and Mizo Hills, harbour about 95% of India's known wild species. With the availability of more irrigation facilities in the near future large areas will come under plough and so the only "refugia" for the wild species are the great mountain ranges of India. It is necessary that such "refugia" are protected by stopping indiscriminate encroachment of forest areas for plantation crops. At the national level there should be uniform policy regarding the optimum hectares required for each plantation crop. The Botanical Survey of India could play a useful role in placing taxonomists at the district level of floristically rich areas to monitor the rate of decline or spread of wild forest species.

There is no alternative to natural habitats in the propagation of rare plants though botanic gardens and seed banks are the only temporary answers to the solution of conservation.

*Establishment of botanical records centre and*

*mapping:* At present botanical information for the distribution of species is available in the National and Regional Herbaria of the country. The Botanical Survey of India is engaged in the preparation of district and National floras and explorations are being undertaken in a planned manner. The Biological Records Centre in U.K. records the occurrences of species in a particular time and particular place. These are used for the preparation of distribution maps and the mapping data are stored in magnetic tapes. The 80 column punched cards, prepare distribution maps on electric-typewriter through a card reader. The Botanical Survey of India with more regional stations specially in areas rich in floristic wealth could establish recording centres for collection of distribution data.

*Role of Systematists in relation to environmental problems:* It is well known that environmental crisis has caused serious concern to Science Policy makers and a critical evaluation of the factors responsible for this is being assessed by naturalists and administrators. In this effort it is to be considered whether systematists could play a suitable role in the solution of the environmental problems facing the country. Systematists along with Ecologists can offer explanation for the causes of population explosion, species decline and extinction. Mosquin (Bioscience 21: 1166, 1971) suggested that systematists could release for the general welfare of the society, the vast stores of facts on distribution of plants and impart environmental education to students from grade one to university level and under take socially relevant research on ecosystem. He concluded (l.c.) "A singular fact about systematics and ecology today is that, while on the one hand we already have vast amounts of information and knowledge about plants and animals and environmental trends, only a small amount of such knowledge is being made available in forms that are comprehensible and meaningful to students, the public and to scientists other than systematists and ecologists" The main contribution that systematists and ecologists could render to society in the present decade is to close the educational gap of environmental education of public and students. Systematists and ecologists should initiate combined projects on species interaction, population explosion, effects of pollution, competition pattern, and plant herbivore relations. Systematists should play an increasing role in the organisation of meaningful environmental curricula in universities and schools.

Through publications they should release information on the environment and educate the public on the environmental disaster resulting from non-planned development of Industries contrary to the ecosystem. Inter-disciplinary research on the basic ecological and biological facts about life on earth should provide information and insights into relationships between plants and herbivores, population explosion and extinction, flowers and pollinators, environment and social behaviour of predators and prey, competition, symbiosis parasitism and disease. It is this kind of research that capture the imagination of students instead of the bare unintelligible theories now being taught in schools and colleges in the name of systematics. It also imparts intellectual exercise for the students in the form of observation, collection, analysis, experimentation and synthesis of conclusions.

*Collaboration with Universities and reorientation of teaching methods:* After years of quiescence, there is a great revival in the study of taxonomy in foreign countries, especially in U.K., U.S.A. and the Continent because of the increasing awareness among the botanists and naturalists that the inventory of the world's living organisms is very inadequately known. For this, since enough expertise is not available, the University Grants Commission of U.K. as early as 1948, created lectureships and chairs in selected universities and taxonomic schools have been built up, as a result of this foresighted policy. In the same way the University Grants Commission of India could play a leading role in the creation of taxonomic chairs in selected universities. There should be a two-way exchange between the Botanical Survey of India and the Universities in the exchange personnel. At present, we are only having some voluntary association with Universities in the form of examinerships and some lectures. It is gratifying to note that recently the Botanical Survey of India has instituted scholarships at universities for the Flora of India revision work and twenty five scholarships have been sanctioned and some scholars have already joined on this project.

It is necessary to give particular attention to the teaching methods and syllabus of taxonomy, since the country depends on universities for the best talent. The present disenchantment of students to systematics and taxonomy is largely due to faulty methods of teaching taxonomy to students at the

undergraduate, graduate and postgraduate levels. Usually teachers who handle this subject have paid undue importance to classification and abstract plant names in their class room lectures. In many cases there is no teacher involvement in field or nature education. It is also seen in many cases that students are not taught how plants are classified by a simple method of correlating similarities and dissimilarities, how plants are given names, and what they stand for. It is easy to remember the genus *Caesalpinia* Linn. if students know the origin of the name i.e. named after Andreas Caesalpini (1519-1603) an Italian Botanist and Physician to Pope VII. So also the genus *Avena* Linn. ; the latin name *Avena* means oats ; originally it came from the sanskrit root *av* which means to satisfy oneself since the plant has long been used as food.

Instead of teaching students from species to genus and then to higher hierarchy like the family and order, usually students are asked to cram family characters as if they are ordained to be in the plants as such. If the students are allowed to study in an inductive way by field observations and reasoning, the study of taxonomy can become very interesting. In this major thrust of any educational programme with a revised and comprehensive syllabus including all modern concepts of taxonomy and environmental studies, the Botanical Survey of India could play a major role and ways may be found for seconding competent botanists from the Botanical Survey of India to universities. Besides, the chief aim must be to attract students to taxonomy and systematic botany keeping in mind that they will have satisfying future prospects in their career, commensurate to their training.

*Biological field stations for Visual Education of Flora for students:* Floristically rich areas like Mussoorie (Uttar Pradesh), Pachmari (Madhya Pradesh) and Kemmangundi (Mysore) should be preserved providing primary facilities like accommodation and field laboratories for students and teachers. This will inculcate in the minds of students, an interest and proper concept of the rich and varied plant life and their ecosystems.

*Post-graduate Training in Taxonomy:* It would be useful for the country if the Botanical Survey of India could start a postgraduate scheme of training in taxonomy and systematics to interested students.

A training in floristics is a prerequisite for any future specialisation in Plant Taxonomy. Taxonomic expertise cannot be built up by a training course as

it is a knowledge which comes after years of experience. So, the primary requirement for any would be taxonomist is basic practical floristic training. The concept of family or generic revisions can be attained only after 5 to 10 years experience in the subject and promising students of floristics can later develop into future systematists. With this end in view and understanding and the present stress laid on environmental crisis, it is felt there should be a training in Floristics which can have a practical bearing for the welfare of the nation.

#### SYLLABUS FOR THE TRAINING COURSE

History of botany with special reference to India and other tropical countries.

Aims of Taxonomy.

History of classification—prior to and after Darwin.

Different systems of classification (Artificial, Natural and Phylogenetic)—their merits and defects.

Definition and use of terms—primitive or unspecialised versus advanced or specialised characters; quantitative and qualitative characters; 'good' and 'bad' characters; homology and analogy; parallelism and convergence.

The units of classification—the taxonomic hierarchy, the concept of species, intraspecific categories, genus and family.

Phytogeography—methods of collection, classification and interpretation of data; recognition of phytogeographical realms, regions etc.; an account of the works of Good, Turrill etc.; plant distribution and migratory tracts; age and area hypothesis; continental drift theory and land bridge theory; endemism (neo- and paleoendemism), oceanic islands; detailed account of the phytogeographical work in India.

Herbarium methodology including lower groups; field methods and exploration.

Important herbaria and botanical gardens of the world.

The use of floras; writing of revisions and monographs; presentation of data for publication.

Identification of Indian plants with the help of keys; preparation of artificial keys for species and genera.

Mechanisms favouring inbreeding—cleistogamy, self pollination. Mechanisms favouring outbreeding—dioecism, heterostyly and self incompatibility mechanisms.

Other recent disciplines of botany in relation to taxonomy.

Botanical nomenclature including nomenclature of cultivated plants.

Evolution and differentiation of species—abrupt and gradual speciation; race; species and isolating mechanisms, geographical and ecological isolation, seasonal and temporal isolation, with a detailed account of 'pollination syndromes'; internal barriers. Crossability and species definitions—morphology at variance with crossability; different fertility relations in different parts of a species area and between related species.

Origin of cultivated plants—origin of cultivated species of *Banana* and *Rice*.

Taxonomic literature.

Taxonomic value of vegetative characters.

Theories on the origin of Angiosperms.

Some special aspects of fruit and seed dispersal.

Raunkiaer's life forms.

Biosystematics—fairly detailed accounts of the experiments of (a) Jordan (b) Bonnier (c) Turesson (d) Clausen, Keck and Hiesey and (e) Gregor; concept of ecads, ecotypes, eco-species, coeno species etc.

Deme Terminology.

Species concept—non-dimensional, typological and multi-dimensional species concept; evolution of species—sympatric and allopatric; taxonomic treatment of polyploids.

Conservation and utilisation of plant genetic resources.

Nature conservation and its influence on the biosphere.

Some Indian National Parks as examples of natural ecosystem.

Problems of Pollution and Environmental Ecology.

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 SENGUPTA, J. C. Botanical Survey of India. The past, present and future. *Bull. bot. Surv. India*. 1 : 9-29, 1959.  
 Tinker, J. *New Scientist*, 50 : 408. 1971.