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CHANGING PATTERNS OF THE INDIAN FLORA

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INTRODUCTION

The outstanding characters for the understanding of the phytogeography of India is the knowledge of origin and complexity of the component elements of its flora and the peculiarities of its distribution in time and space due to geomorphological changes and the interactions of the climatic and biotic factors. According to J. D. Hooker (1907) "The Flora of British India is more varied than that of any other country of equal area in the Eastern hemisphere, if not the globe. This is due to its geographical extension, embracing so many degrees of latitude, temperate and tropical; to its surface rising from the level of the sea to heights above the limits of the vegetation; to its climates varying from torrid to arctic and from almost aridity to a maximum of humidity and to the immigration of plants from widely different bordering countries, notably Chinese and Malayan on the east and south, of Oriental, European and African on the west and of the Tibetan and Siberian on the north" This view of Hooker on the phytogeography of India is quoted often to show the luxuriance of the Indian Flora. Thanks to intensive plant explorations and taxonomic work in India and southeast Asian countries during the last few decades, it is seen that species diversity of the Indian flora is not as rich as it was once thought to be, considering the size of India and its geographical position. In this it is considered prudent to accept the view of Good (1953 p. 191) that "Hooker gave an exaggerated impression of the floristic richness of the Indian region" As India is one of the fertile regions of the world with a civilization going back to centuries, it is one of the areas of the world where population pressure has changed beyond recognition the primeval vegetation of India. The Angiosperm flora of India has about 15,000 species and it is distributed over 2,252 genera and over 304 families. This represents about 6% of the known flowering plants of the world, considering the world total of 2,50,000 species. Comparing the countries included in the Flora Malesiana or Brazil of South America, taxa per sq. km is far less. Whereas the smaller Malesian region has about 25,000 species of flowering plants and it represents about 10% of the world flora. (van Steenis 1977).

GENERAL FEATURES OF INDIAN FLORA

The Peninsular India and the Himalaya are the principal biogeographical regions of India with Indo-gangetic plains sandwiched between them. Considering the geographical position of the Himalaya which harbours

and accepts as pathway the temperate floras of the Pamir axis, the Tibetan plateau, Turkmanistan and Uzbekistan of Soviet Russia on the north and of the flora of south-east Asia from Yunnan-Burma-Thailand triangle, the flora of Himalaya is characteristic of the adjoining countries through which the Himalayan Ranges straddle. The endemic nature of its flora is that of the Himalaya and not of any political State as recent studies have shown that many species thought to be endemic to Assam Himalaya occur in Burma and Yunnan axis. While the Indo-gangetic plain sandwiched between the Himalayan Ranges and the Deccan plateau, partly due to lack of strong physiographic features and also partly due to intense biotic activities, functions as the artery for the spread of native and alien species in the sub-continent. Peninsular India, bounded in the north by the Bundelkhand and Rajmahal hills has a characteristic flora and the true Indian flora is reflected in its components, as it is the original flora of India, derived from the ancient Gondwanaland.

Out of about 304 families of flowering plants recorded from India, there is not a single endemic family. In India there are only about 140 endemic genera and this figure only represents 6.5% of the Indian flora. Chatterjee (1962) estimated about 6,700 species endemic to India and this estimate is considered high as recent studies of taxonomic revisions have shown. Many species previously thought to be endemic are either reduced or located in the adjoining geographical territories. Blasco (1971) has estimated about 1268 endemic dicotyledens in South India, of which 690 endemics are orophytes. On studying and evaluating taxonomic monographs and distributional data, it is estimated that there are only about 4500 endemic species in India. While the Peninsular India has an endemic concentration of 32% (2100 endemic species out of 6500 species), the rest of India has about 27% endemics. The extent of endemic species in the Indian Flora has to be progressively evaluated as more and more taxonomic and distributional data become available. The question which requires answering is whether the present day India has a distinct flora of its own like that of the Flora of Madagascar, or S. Africa or that of Australia. The Flora of Australia has a high degree of endemism with 60% of genera and 80% of species endemic. Madagascar has a rich endemic flora, as high as 85%. The characteristic flora of India is that of Peninsular India which is relictual of a bygone age as shown by the presence of more paleoendemics. Whereas the flora of Northern India excepting the plains, is the flora of Himalaya of recent origin and is in a state of evolution with a number of neoendemics and related species complexes. The flora of Himalaya and adjoining mountain ranges branching out into South-east Asia has a characteristic flora of its own. The present distribution of flora of India can only be studied in the background of the world distribution of families, genera and species with its past and present status. It is also necessary to understand the evolutionary pressures which acted on the distribution and extinction of plants in the past due to paleoclimatic changes.

THEORY OF PLATE TECTONICS AND THE DISTRIBUTION OF FLORA

For understanding the present phenotypes of the Indian flora it is necessary to study the fossil evidences constituting the Indian flora. The Glossopteridean flora which is considered gymnospermous (after Pant's reconstruction) has clearly established the Gondwana origin of land mass comprising the S. America, Africa, India with

Malesian islands, Madagascar, Australia and Antarctica. The Indian portion of Gondwanaland has characteristic Glossopteridean (Paleozoic) flora consisting of form-genera *Gangamopteris* (leaf impression), *Glossopteris* and fossil wood *Dadoxylon* and winged spore *Pityosporitis*. The Paleozoic deposits of Australia, S. America also showed the Glossopteridean flora. Recent discoveries of Glossopteridean fructifications have shed light on the problem of conversion of gymnospermous fructification into an angiospermous flower and it is possible to visualize how the male fructification of *Eretmonia* could have been transferred into the androecium of Proteaceae (Melville 1975, Surange & Chandra 1974). Fossils of the dinosaur genus *Laplatsaurus* in the upper cretaceous of Madagascar, S. America and India offer biological proof of the connection of these continents.

The theory of plate tectonics or continental drifting provides basis for otherwise incomprehensible patterns of distribution of families, genera and species which cannot be easily visualised in terms of present day dispersal and migration or landhopping. Plate tectonics visualizes the earth's crust consisting of several rigid plates with 50 to 100 km thick and they move or slide or rift in relation to one another sometimes at the rate of 10 cm per year. This jostling creates earthquakes at the margin of plates or the flow of lavas or volcanic eruptions. Paleomagnetic evidence shows that S. America, Africa and India separated from the remainder Gondwanaland early in the Triassic and the flora at this point of time might have evolved from the ancestors of permean age. The southern Gymnosperms, now mainly restricted to southern hemisphere previously was quite common in India. At present, the sole living representative of Podocarpaceae of S. India *Decussocarpus wallichianus* occurs in south Kerala. The family Podocarpaceae is of southern origin, in a cool temperate latitudes of the southern hemisphere. The history of flora of Peninsular India is one of floristic impoverishment and as the Indian plate moved north to southern arid, to tropical and northern dry latitudes its flora underwent changes causing extinction of species and adaptive evolution of few species which could face new stresses and strains. The oldest fossil pollen which is determined as angiospermous is from the early Cretaceous, some 125 million years ago and by the close of Cretaceous (67-70 million years ago) a number of modern families Palmae, Myrtaceae, Proteaceae) were in existence. The jurrassic flora of Rajmahal hills shows the existence of cycads, ferns and conifers and Sahni (1932) described *Williamsonia sewardiana* looking like living cycas. The fossil male and female cones of Podocarpaceae were described under *Nipaniostrobus* and *Sitholeya*. The jurassic *Sahnioxylon* Bose & Sah believed to be a primitive vesselless dicotyledonous wood, now considered to be of bennettiatalean origin (Hsu & Bose, 1952). The tertiary flora discovered from India are mostly fossil woods, palms and dicotyledons, leaf inpressions, fruits and seeds, such as *Palmaxylon sahni, Sahnianthus parijia, Sahnipushpam glandulosum, Cynometroxylon* and *Dipteroxylon* etc. The closing of the Tethys sea, raising of Himalaya as a result of the meeting of the Indian plate with the Asian block were important events in the history and evolution of the Indian flora. The gradual impoverishment of Peninsular flora due to the climatic changes during the Palaezoic and Mesozoic Era and the flow of deccan lava during Cretaceous-Eocene times and the Pleistocene glaciations in the Himalayas affected *in toto* the floristic composition of India.

SOUTHERN ORIGIN

The following evidence on the present distribution of the following families indicate the nature and distribution explained in terms of plate tectonics and southern origin of Indian Flora.

Melastomataceae : Nayar (1972) has shown that the Family Melastomataceae has a common origin in the Gondwanaland and those blocks that separated carried their own share of melastomataceous flora which after gradual establishment in new situations during long span of time and space, proliferated into several new taxa by an intensive process of evolution. Melastomataceae is a homogenous family of about 220 genera and 5300 species and is generally confined to the tropical and subtropical regions avoiding arid conditions and attaining prolific developments in the rain forests between the tropic of cancer and the tropic of capricorn. There is no genus common to both the New World and Old World. At the tribal level, tribe Memecyleae is common in the Old World and New World; whereas, the genus *Memecylon* represents the Old World and the genus *Mouriri* Aubl. represents the New World. Within the Old World Melastomataceae, the situation is different as several genera and five out of eight tribes are shared by the tropics of Africa and Asia.

Pittosporaceae is a family of the Old World, of the southern hemisphere with about 9 genera of which 6 are confined to Australia. Genera *Hymenosporum* and *Citriobatus* occur in S. E. New Guinea and E. Australia. The genus *Pittosporum* with about 300 species occurs in Australia, Malesia, Asia, Madagascar and Africa. *Pittosporum* is poorly represented in India with about 10 species, of which 4 are confined to W. Ghats; *P. floribundum* occurs in Madagascar and S. India; *P. ceylanicum* occurs in S. India and Ceylon. The present distribution of the family can be visualised in terms of Gondwanaland origin of the family.

Proteaceae : C. V. Rao (1971) after study of Proteaceae indicated that the origin of the family is in the southern hemisphere in a connected landmass, Pangaea or Gondwanaland. A family of 60 genera and of about 1300 species with the highest species concentration in Australia (750 sp.), Malesia, S. E. Asia, Africa, Madagascar, Central & S. America; *Helicia robusta* and *H. nilagirica* occur in S. India and *H. ceylanica* occurs in Ceylon. There are large number of fossils attributed to Proteaceae. Hooker (1860) indicated that the fossil fruiting cones of Proteaceae reported from Victoria (Australia) are identical with those of *Banksia ericifolia* L. The male fructification of *Eretmonia* is supposed to be the ancestor form of Proteaceous androecium (Melville, 1975).

Dilleniaceae : Dilleniaceae presents an admirable example of the origin of the family from Gondwanaland stock. This is a tropical family comprising of trees, shrubs and stragglers, distributed among 10 genera and about 400 species in S. America, Africa and S. E. Asia and Australia. Tribe Delimeae is American excepting the genus *Tetracera* (40 sp.) which is pan-tropical. Tribe Dilleneae occurs in S. E. Asia and Africa with 7 genera. Tribe Hibbertieae is mainly Australian excepting the genus *Hibbertia* (150 sp.) which occurs in Madagascar, New Guinea, New Caledonia and Australia. *Wormia* (50 sp.) occurs in Ceylon, Malesia, N. Australia, Fuji and Madagascar. According to Stebbins (1972) "The Dilleniaceae provide an admirable example of ancient adaptive radiation from intermediate habitats both toward xeric and more mesic adaptations"

Gramineae : Clayton (1975) after detailed study of chorology of the family Gramineae favoured the distribution of genera in terms of continental drift. Though Gramineae is one of the advanced families, Clayton (1975) considered that this family had evolved their essential tribal and even sub-tribal level characteristics by the end of the Cretaceous.

These examples of families illustrate the contention that angiosperm history is closely associated with plate tectonics or continental drift. The studies of large number of workers on the distribution of families (Clayton 1975; Cox, Healy and Modie 1973; Howden, 1974; Melville in Adams & Ager, 1967; Nayar 1972; Tarling 1971) illustrate the underlying concept of Gondwanaland origin of many Angiosperm families. The transoceanic migration of species, may not be readily considered as a possible way of explaining distribution of present day distribution of genera and species excepting migration of weeds which has developed their strategies both genetical and ecological, in meeting new situations or movement of economic plants through human societies in different centuries as a part of human migration and settlement.

DISTRIBUTION OF GENERA IN INDIA

The following examples of the distribution of genera illustrate the nature and origin of these genera in terms of the Indian block of Gondwanaland.

Nepenthes (Nepenthaceae) : A genus of pitcher plants with about 67 species, one species in Madagascar, one species in Ceylon, one species in the Khasi hills (India) and the rest extending to S. E. Asia, Malesia, N. Queenslands and New Caledonia, offer an example of isolated distribution, but can be fitted in the concept of Gondwanaland.

Hernandia (Hernandiaceae) : A genus of twenty species occurring in Madagascar, Ceylon, Southern and Eastern India, S.E. Asia, Malesian islands, and eastern Australia in the Old World and West Indies, Central America, Guiana in the New World and Cameroon Africa.

Lurembergia (Haloragaceae) : A genus of 4 species occurring in S. Africa, Madagascar, eastern S. America, Southern tip of India, Ceylon, Sumatra & Java. *Lurembergia coccinea* occurs in southern tip of India, Ceylon, Sumatra and Java.

DISTRIBUTION OF SOME CHARACTERISTIC GENERA IN THE INDIAN BLOCK WHICH INCLUDES MALESIAN ISLANDS

The readjustment of the Indian block of Gondwanaland along with the Antartic continent as shown by geological evidences, clearly indicates the Godavari fissure fitted in with the Antartica. In the older Gondwanaland reconstructions, the present Bay of Bengal was shown to be filled up by the portion of Australia. Since the Malesian islands drifted apart eastwards in the course of northward movement of the Indian block, the Malesian islands in the course of millions of years developed a very characteristic flora, but at the same time shows remarkable common ground pattern in the floristic composition of peninsular India, Ceylon and Malesian islands. This is illustrated in the following examples :

Icacinaceae : The species *Sarcostigma kleinii* occurs in southern Western Ghats of Deccan, Andaman islands, Malaya peninsula, Java, Borneo and Indo-China. *Nothapodytes foetida* occurs in southern Western Ghats, Ceylon, Burma, Thailand, Sumatra, Philippines and S. China.

Apodytes dimidiata occurs in the southern tip of India, Ceylon, Thailand, Sumatra, Java, Borneo, Philippines and Moluccas. The genus *Gomphandra* occurs in southern Western

Ghats and Ceylon and south-east Asian and Malesian islands.

Acrotrema (Dilleniaceae) : A genus of 10 species, one species occurring in Southern Western Ghats and 8 species in Ceylon and the one species occurring in Burma and Malaya peninsula. This shows a remarkable ground plan and this distribution can only be explained as part of Indian block of Gondwanaland.

Trichopus (Trichopodaceae) : *Trichopus zeylanicus* occurs in southern Western Ghats, Ceylon and Malaya peninsula, while the related genus *Avetra* occurs in Ceylon and Madagascar.

Wormia (Dilleniaceae) of about 50 species occurring in Madagascar, Ceylon, Malaya peninsula, Malesian islands, Australia and Fuji islands.

Hydnocarpus (Flacourtiaceae) consists of 40 species occurring in Western Ghats, Ceylon and south-east Asia, Malaya peninsula, Sumatra, Java, Borneo, Celebes and the Philippine islands.

In the family Monimiaceae the genus *Hortonia* is endemic to Ceylon and the genus *Matthaea* occurs in Malesian islands while the genus *Ephippiandra* occurs in widely different areas in Madagascar, E. Africa, S. America, Australia & New Zealand.

From the above exemples of distribution of genera and species it is seen that the disjunction in the distribution can only be explained on the basis of Indian block together with Burma and Malesian islands carrying its share of species drifting away from a common Gondwanaland. If there is large scale migration of species on the basis of transoceanic and transcontinental dispersal many of the present day disjunctions could have been closed years ago and there would have been uniform vegetation in the same climatic zones. It is suggested here that long range dispersal of many tropical tree species is comparatively poor and one of the reasons could be their poor reproductive or dispersal strategies. It is seen that many tropical trees generally have limited seed dispersal range, poor viability of seeds and they require their own ecosystem for survival. They could not stand competition with the secondary heliophile species which have seeds with more vitality and longer dormancy period. Hence it is not out of place to say that primary forests of tropical belt are easy to destroy but difficult to regenerate. Barring few, many tropical tree species representing relicts of a bygone age have not shown genetic dynamism for survival as the present disturbance in the ecosystem is on a scale and momentum so vast that these species could not adjust or 'experiment' for newer pathways of adaptive radiations. In a sense, tropical plants especially trees are in a state of "rigor semi-mortis"

DISTRIBUTIONAL PATTERN OF INDIAN FLORA

Himalayan Flora : The uplift of the Himalaya created a vast chain of events in the shaping of land formations, climate and river systems which affected the whole compositions of the Flora of India and as Mani (1974) said "The Himalaya presides over the ecology and biogeography of India". The Himalayan mountain chains functioned as a pathway for the flora of temperate species of Pamir and Central Asia from the north and Sino-Japanese species from the north-east and south-east Asian species from the south-east. Though the Himalayan range acted as a geographical barrier it also functioned as a crucible for the evolution of new species complexes in the sanctuaries offered by the Himalayan mountain system. Besides this, many phylogenically primitive families of plants could escape extinction due to isolation and inaccessibility of the Himalayan

ranges branching from N. E. India to Burma, South China and Thailand. The occurrence of phylogenically primitive families *Magnoliaceae, Digeneriaceae, Himantandraceae, Eupomatiaceae, Winteraceae, Trochodendraceae, Tetracentraceae* and *Lardizalbaleaceae* in south-east Asia led Takhtajan (1969) to consider the area as the cradle of the flowering plants. On the other hand Smith (1970) indicated that the countries bordering pacific ocean as the centre of origin of Angiosperms based on the presence of few primitive families along the shores of the pacific ocean countries. It is suggested here that the S. E. Asian flora is part of the Gondwanaland flora brought through the Burmese and Malesian portion of Indian block joining with the Asian mainland and the inaccessible terrain of Himalayas helped in the preservation of the remnants of few primitive families. Hence it is appropriate to consider S. E. Asian plexus with numerous flold of mountains a "refugium" and not a cradle of flowering plants as this area is only a small part of the vast spectrum of Angiosperm distribution and evolution.

Peninsular Flora : The Western Ghats and the Deccan have characteristic floristic elements with about 2100 endemic species (out of about 6500 species) and this represents 32% of the flora. The Asian-Malesian-Ceylon elements contribute roughly 40%. There are large number of aliens and "wides" and they represent roughly 26% and the rest 2% of the flora shows African and Madagascan affinity. In this vast spectrum of floristic composition, there are a few temperate species in the Nilgiris which shows relationships with the temperate flora of Assam Himalaya. (*Ternstroemia japonica, Rhododendron arboreum, Hypericum hookerianum, Thalictrum javanicum, Cotoneaster buxifolia, Parnassia wightiana, Lonicera ligustrina, Gaultheria fragrantissima, Symplocos lauriana* etc.). On the basis of its similarity, it is considered by some botanists that the temperate flora of Nilgiris are part of Pleistocene relicts. This view is based on Medlicott and Blandford's (1879) suggestion that general lowering of the atmospheric temperature during the pleistocene glaciation resulted in the movement of northern temperate flora and fauna towards the equator and with the retreat of Pleistocene glaciers those flora and fauna left in the equitorial region found refuge in the hill tops as Pleistocene relicts. It is suggested here that these temperate elements are part of the high altitude mountain top S. E. Asian flora and their origin and evolution is quite independent of forward or backward movements of Pleistocene glaciers and their relationships with Himalayan elements are probably due to convergence. It is considered that the present disjunction in their distribution occurring in the Nilgiris in South India and Assam Himalayas is due to favourable ecological niches afforded by these mountain tops. The intermediate link is lost because of climatic and physiographic changes. Blasco (1971) commented that Hooker and Thompson (1855) committed the first error in comparing some temperate elements of Nilgiris with that of the Himalaya because botanical explorations were at the initial stage and hence the world distributional data were not available then. Hooker and Thompson's views were however supported by various authors (Biswas 1949; Fyson 1918; Gupta 1962; Mukherjee, 1935). As distributional data of S. E. Asian plants are available now, thanks to the work of Flora Malesiana in the context of Peninsular Indian plants, it is appropriate to consider south Indian plants are remanants of an earlier much wider spread. Mani (1974) emphasised that "the area of present day concentration and isolation of the dominant elements of the flora and fauna especially in the Peninsula do not by any means mark the centres of radiations of the original peninsular complex but re-

present on the other hand the refugial islands"

Hora (1944, 1948, 1949, 1950) advocated that the Satpura Ranges as the connecting link for the movement of fauna from Assam gateway to south Indian block on he basis of certain mountain stream fishes in Assam and Western Ghats. This hypothesis known as Satpura hypothesis was supported by Hora's school of Zoologists (Jayram, 1949, Menon, 1951, Silas 1952) and later on by botanists (Biswas, 1949) as a possible route of the migration of Assam Flora to South India. Geologically Auden (1949) disproved the Garo-Rajmahal connecting link, a main plank of Satpura hypothesis. Kurup (1966) after a study of mammals has come to conclusion that present day discontinuity is essentially a relict of former distribution. Movement of floras through mountain system (Satpura hypothesis) though it is an attractive answer to explain the occurrence of spatially separated identical taxa, is rather a farfetched view. This hypothesis gives low premium to climatic barriers and different photoperiods occurring in the same mountain chains which have wide latitudinal ranges. From the study of distribution of angiosperms, in S. E. Asia and Malesia, it is seen that the present distribution of plants in peninsular India corresponds with the general distribution in S. E. Asian countries and the present day disjunction is a relictual feature. It is wrongly assumed that all plant species disperse and migrate just as aggressive weeds over the length and breadth of country through some mountain system irrespective of its genetical and ecological parameters. As Blasco (1971) indicated that the hills of South India and Ceylon are poor in residual floras and the presence of a few temperate species does not warrant the assumption of the movement of floras during glaciation. The genus *Rhododendron* has about 500-600 species mainly occurring in the Himalayan ranges spreading from N. E. India-Burma-Yunnan triangle, while the second centre is in N. America. The occurrence of species *Rhododendron arboreum* in the Nilgiris does not indicate the southward movement of temperate flora during glaciation. In this connection, it is interesting to note the occurrence of *Rhododendron lochae* in tropical Australia. Hence it is suggested here that the occurrence of *Rhododendrum arboreum* in Nilgiris is due to convergent evolution in a favoured ecological niche, while its connecting link to Himalayas was lost due to physiographic and climatic changes. Razi (1955) from the analysis of the South Indian hill tops confirmed the similarities of the flora of South Indian hills and the Himalaya and proposed that migration of flora has occurred both ways, southwards and northwards and the provinces of Bihar and Orissa played an important role in this north-south migration. This is a compromise of the theory of glaciation relicts, Satpura hypothesis and the southern origin of Angiosperms (Hill 1926). On the other hand from the study of the disjunct pattern of distribution of several families and genera and relictual flora in Madagascar, Ceylon, Peninsular India, S. E. Asia, Malesia and Australia and S. America & from meagre fossil evidences, it is clear that angiosperms arose as a group on the southern landmass during Palaeozoic and reached its evolution through familial rank by mid-Measozoic and moved northward as a part of tectonic continental drifting by the Cretaceous (Camp, 1947). At present as the Himalaya presides over the biogeography of India, the Western Ghats to a large extent presides over the ecology and biogeography of Peninsular India.

FLORISTIC ELEMENTS

The important floristic elements constituting the Flora of India in the north due to the

Himalayan upliftment are the temperate Asian elements, the Mediterranean elements, the steppes elements, Indo-Chinese and Malayan elements whereas the Indo-gangetic plains acted as a pathway of adventive mediterranean and Saharian elements into India. The tropical Asiatic elements have S. E. Asian and Malayan affinities and they constitute the dominant element in the Indian Flora. The tropical S. E. Asian and Malayan elements in India constituting of about 35% of its flora is a relictual flora indicating its once wider spread in a common connected land mass. On the basis of approximate distributional data it may be estimated that the Flora of India contains the following elements :

S. E. Asian & Malayan elements	35%
Endemic species	30%
Adventive weeds and naturalised aliens	18%
Temperate Asian elements	8%
Mediterranean-Iranian elements	5%
Steppes elements	1%
African elements	2%

Excepting the Himalayan flora, the indigenous flora of India is a relictual flora in "refugiums" of our forests.

QUALITATIVE CHANGES IN THE FLORA

The main causes for the qualitative changes in any Flora are due to the climatic fluctuations, evolutionary changes and the introduction or extinction of species. The first two causes climatic fluctuations and evolutionary changes in time and space resulting in the disjunctions in their distribution or adaptive speciation. Quantitative changes in our flora are going on at varying rates in different parts of our country due to the spread of adventive weeds and aliens as secondary growth in our forests and plains. This is due to drastic environmental changes brought out by man in the forests of India. From time immemorial adventive aliens and weeds reached India through migration of people, import of food grains, through seeds of foreign garden plants and fodder, imported packing materials, skins and hides and through people, vehicles and living animals. These adventive and naturalised plants constitute about 18% of the Indian Flora. In this about 55% of the adventive flora comes from America, 10% from Africa, 20% from Asia and Malesia and 15% from Europe and Central Asia. It is worth mentioning here that all along the waste lands and railway lines of India the common weed *Croton bonplandianum* is seen spreading ; but about 71 years ago Bruhl (1908) noted this species as a rare plant occurring along the foreshore road in the front of the Engineering College, Shibpur, (Howrah). The recent example of another aggressive weed spreading fast is *Parthenium hysterophorus* reported for the first time by Rao (1956) from Poona. During the last 21 years its spread in the Peninsular India has created much alarm since it causes allergic dermatitis and respiratory diseases.

There is general destruction of forests all round due to shifting cultivation, mining of forested areas, construction of dams and introduction of plantation crops. Primary forests are fast disappearing and close canopied. Indian trees are being destroyed and in some places replaced by straight-boled Eucalyptus trees. The regeneration of native forest species is nullified by the clearing of ground flora, shifting cultivation, plantation crops, burning of undergrowths and inadequate collections of propagules and seeds for cultivation. It is a common phenomenon that nurseries are filled with seedlings of Eucalyptus species, *Casuarina equisetifolia* and *Grevillea* species and not of saplings of indi-

genous trees. There is urgent necessity to monitor the loss of Indian forested areas. Most of the afforestation programmes are urbane-oriented with ornamental flower and fruit trees and when it comes to forest lands it is in the form of creating plantations of Eucalyptus and Teak which are revenue-oriented. The wild native trees of India are threatened and there is urgent necessity to make an inventory of threatened trees of India constituting the forest ecosystem and when such a ecosystem is preserved, rare herbs and shrubs get ready protection under their canopy. The practices of cutting down native forest trees of 50 to 200 years old for the production of timber, firewood and charcoal requires evaluation in the context of the preservation of primary primeval forests of India. If left undisturbed our forest regenerates itself in large "forest continuums" and not in isolated patches of "parks and sanctuaries".

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