PART III

PHYTOGEOGRAPHICAL STUDY ON THE FLORA OF MIRIK AND ITS ENVIRONS IN DARJEELING DISTRICT, WEST BENGAL

INTRODUCTION

Phytogeography is a branch of science which deals with spatial relationship of plants both in the present and in the past (Good, 1964). Its aim is to record and then, if possible, to explain the distribution of plants in the region. The study of nativity, distribution, adaptation, association of plants are some of the important aspects in the comprehensive field of plant geography. The phytochoria or bio-geographical regions, the biomes and the flora provinces indicate the different types of plant association in different perspective. As the climatic condition and the edaphic factors are the chief criteria for plant migration, the study on phytogeography of the region understudy may throw some light on the present day ecological condition of the region.

From the literature, it appears that some of the authors (Clarke, 1898; Hooker, 1907; Calder, 1937; Chatterjee, 1939 & 1960) studied the phytogeographical regions of India. Among them, Chatterjee (1939, 1960) introduced the region of Central Himalaya covering Nepal in addition to Eastern Himalaya and Western Himalaya as proposed by most of the authors during separation of phytogeographical regions of India. Thus attempt has been made to study the floristic composition of the plant with special reference to the position of Mirik and its environs from phytogeographical point of view.

REVIEW OF LITERATURE

Several attempts have been made from time to time for a suitable classification of the phytogeographical regions of the world, out of these the classification of Schouw (1923) and Good (1964) are important. Schouw (1923) divided the entire world into 25 kingdoms. Kingdoms were again subdivided into provinces which were named after the characteristic plants of respective provinces. On the basis of the floristic pattern, Good (1964) divided the world into 6 kingdoms. The kingdoms were sub-divided into subkingdoms, regions and ultimately into provinces.

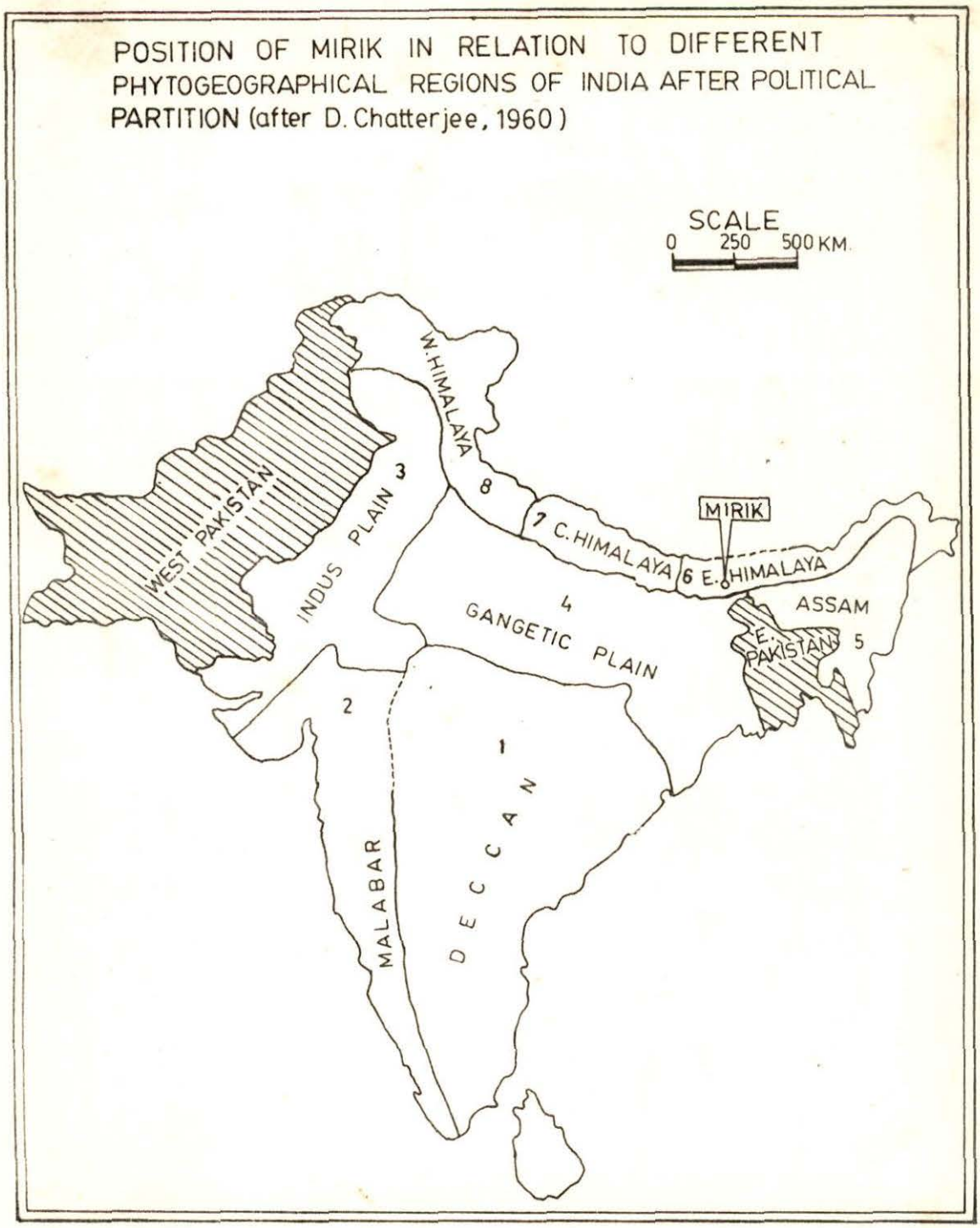
POSITION OF MIRIK IN RELATION TO DIFFERENT PHYTOGEOGRAPHICAL REGIONS OF INDIA AFTER POLITICAL PARTITION (after D. Chatterjee, 1960)
SCALE
0 250 500 KM.
W. HIMALAYA
WEST PAKISTAN
INDUS PLAIN
3
8
7 C. HIMALAYA
MIRIK
6 E. HIMALAYA
ASSAM
4
GANGETIC PLAIN
E. PAKISTAN
5
2
1
MALABAR
DECCAN

Fig. 60.

In connection with the study on the phytogeographical regions of India, it has been noted that Hooker (1855b) in his "Introductory Essays to the Flora Indica" and subsequently in the "Imperial Gazetteer of India" - Botany Section, published in 1907, divided British India into 9 phytogeographical regions. Clarke (1898) in the "Journal of Linnaean Society" proposed a somewhat different classification of Indian floristic regions. He divided British Indian into 11 botanical regions or sub-areas. On the basis of climatic and physical conditions, floristic features etc., Calder (1937) divided British India into 6 botanical regions. All these authors included the area under study in the botanical region of Eastern Himalaya. Chatterjee (1939) in the "Studies on Endemic Flora of India and Burma" divided the then British India into 10 phytogeographical regions. After the political partition of the sub-continent of British India into Indian Dominian and Pakistan in 1947, Chatterjee (1960) suggested a revised scheme of the phytogeographical regions of Indian Dominian (Fig. 60). In his scheme, he showed only 8 distinct botanical regions of India proper excluding Burma (with Upper and Lower) and the regions under both western and eastern Pakistan (now Bangladesh). In both the schemes proposed by Chatterjee (1939, 1960), the most characteristic feature was the establishment of Central Himalaya (covering Nepal) along with Eastern and Western Himalaya. According to him, the region under study fell under Eastern Himalaya like all other previous authors.

METHODOLOGY

The work was carried out on the following lines of investigation :

(a) Field study : Collection and identification of different plant materials were performed according to the procedure mentioned in the methodology for taxonomic study on the flora represented in Part II of the thesis.

(b) Consultation of authentic herbarium sheets and literature : Various authentic herbarium sheets deposited in different herbarium sections of North Bengal University, Lloyd Botanic Gardens in Darjeeling, Central National Herbarium (Botanical Survey of India, Howrah, Calcutta) and Indian Museum

(Calcutta), were consulted specially for understanding their geographical distribution. In this respect various literature such as floras, monographs, journals have also been consulted in different libraries specially for understanding their nativity or country of origin and distributional pattern in India and abroad. Besides, some information on phytogeography of some of the plants have also been gathered from Royal Botanic Gardens, Kew, London.

In discussion, only a few representative species have been mentioned avoiding space though information all about phytogeography of different species has already been represented in Part II dealing with the taxonomic study on the flora of Mirik and its environs in Darjeeling district.

ANALYTICAL STUDY AND DISCUSSION

Plant geography is one of the branches of Botany which deals with the spatial relationship of the plants both in the present and the past. The main aim and object of plant geography is to record and then to explain the distribution of plants over the surface of the world. This branch of botany is intimately connected with plant ecology to constitute a new and much more wider subject known as "geo-botany", which comprehends all aspects of the relation between plants and the surface of the earth that is the substratum of their lives (Good, 1964). Plant ecology is particularly concerned with the way in which plants are mutually related to one another and to the conditions of their habitat.Plant geography on the other hand, is concerned primarily with the correlation between plants and the distribution of external conditions (Good, 1964).

According to Good (1964), expressed in another way, the difference between vegetation and flora and a clear understanding of these two are important. The observations on vegetation in Mirik and its environs have already been narrated in the plant ecology section in Part I. The floristic account of the region under study has already been reported in Part II represented earlier.

As India is surrounded by widely separated countries and is a part of the large continent, so there is a great diversity in opinion whether India has a

characteristic flora of her own or not; this diversity in opinion is due to the richness and great variation of plants in India. According to Hooker (1904) and Champion & Trevor (1938) ithas a mixture of flora of the surrounding countries like Malaya, Africa, Tibet, Orient, China and Japan. But Chatterjee (1960) from his critical studies on Indian vegetation concluded that "India has a flora of her own" because India has not only a rich endemic flora but also a large amount of endemic species. According to the estimation of Chatterjee (1939)61.5% of the plants are endemic in British India i.e.India including Pakistan and Burma; the rest 38.5% of the total plants occur as "wides" as they are also found in other countries. In 1960, Chatterjee showed that partitioned India (i.e.,India excluding Pakistan, Burma and Ceylon) containing more than 50% of the dicotyledonous species were endemic. These endemic species are largely concentrated in two regions viz. (a) The Himalayas, (b) South India.

Recently, Banerjee et al. (1980), though their observation is mainly based on that of Hooker (1854), published in Himalayan Journal, reported that the vegetation in the northern parts of Darjeeling and Sikkim is European and North American, having the union of the boreal and temperate flora of the east and west hemispheres accompanied by few features peculiar to Asia. According to them, northern Darjeeling and Sikkim are nearly equi-distant from the tropical forest and Terai and the barren mountains of Tibet, for which reason representatives of both the dry Central Asiaic and Siberian and of the humid Malayan flora meet here. Of the flora in and around Darjeeling town, including both wild and cultivated species, nearly 50% are indigenous to the Himalayas.Of the rest Japan has supplied about 14%, N. America 7%, Australia and China 6% each, Malaya and Europe 4% each, S. America and tropical zone of Asia 3% each, C. America 2%, Burma 1% and Africa 0.5%. Of the non-endemic elements, migration of the Malayan species was facilitated by land connection between the two countries.

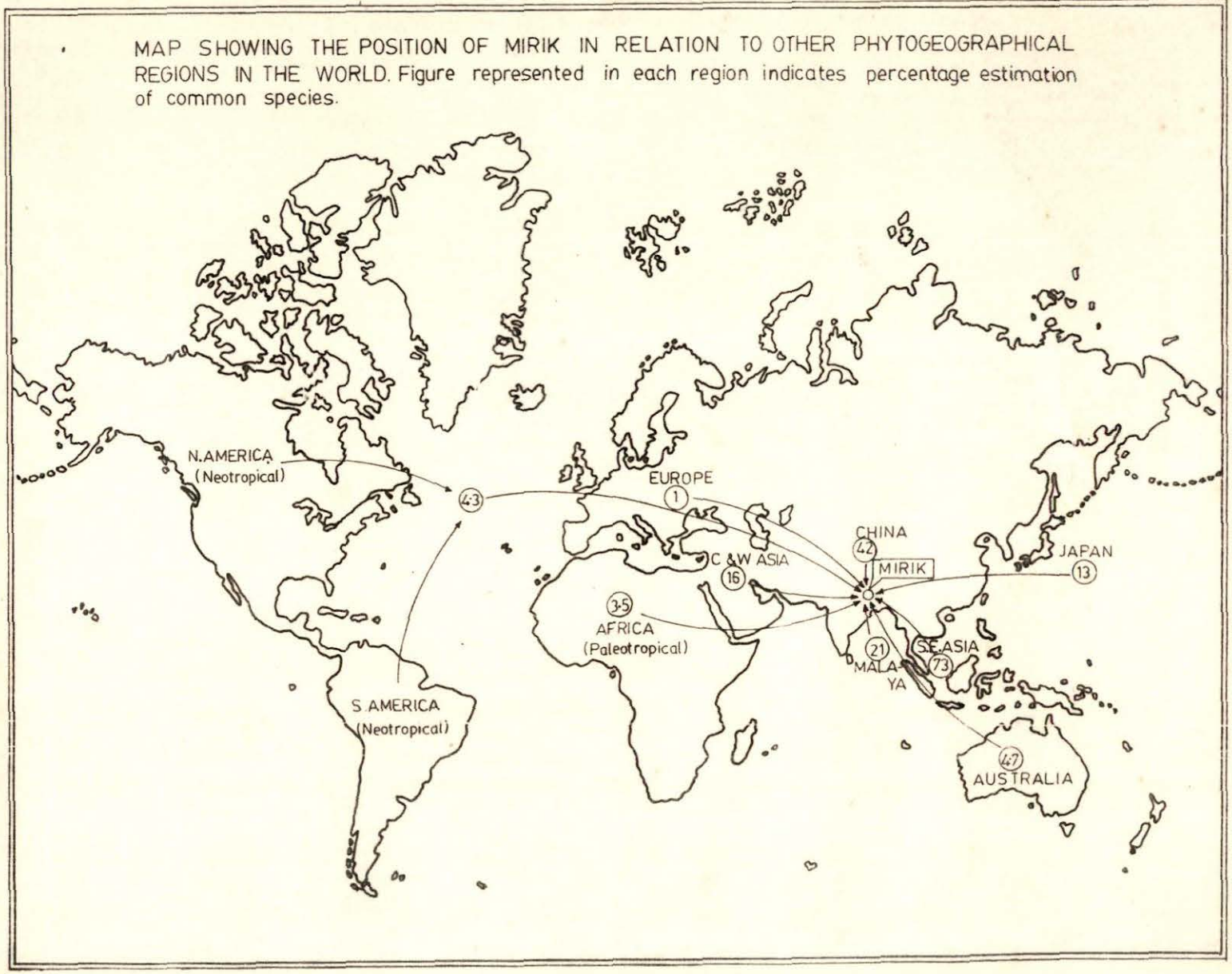
MAP SHOWING THE POSITION OF MIRIK IN RELATION TO OTHER PHYTOGEOGRAPHICAL REGIONS IN THE WORLD. Figure represented in each region indicates percentage estimation of common species.
N.AMERICA
(Neotropical)
4·3
EUROPE
1
CHINA
42
MIRIK
JAPAN
13
C & W ASIA
16
3·5
AFRICA
(Paleotropical)
21
MALA-
YA
S.E.ASIA
73
S.AMERICA
(Neotropical)
47
AUSTRALIA

Fig. 61.

TABLE - XI

Percentage occurrence of species (excluding cultigens) observed in Mirik and its environs and common to different botanical regions in the World.

Neotropical	Palaeotropical	European	Chinese	Sino-Japanese	Japanese	Malaysian	South East Asian	Central & West Asian	Australian
4.3	3.5	1.0	42.0	13.0		21.0	73.0	16.0	4.7

Some observations different from those of earlier workers have been made while studying the flora of Mirik and its environs from phytogeographical point of view. Observations represented in Table XI are based on the comparative study on the flora of corresponding region with that of the region under study and also on the basis of examinations of different herbarium specimens collected in Central National Herbarium of the Botanical Survey of India, HOW (CAL) and Herbarium of the Industrial Section, Indian Museum (BSIM).It appears that American (Neotropical) species are represented by only 4.3% . On the other hand, European, African(Palaeotropical), Malaysian, Chinese, Japanese and Australian species are represented by 1%, 3.5%, 21%, 42%, 13% and 4.7% respectively (Fig. 61).

Difference of observation as compared to that of Banerjee et al. (1980) is probably due to the fact that their observation was based mainly on Darjeeling town and adjoining areas and also due to the fact that during their calculations, they included the cultivated species also. Moreover, as per observation reported by Banerjee et al. (1980), it is not clear whether the respective region as mentioned by them were the source of the species as their native representative. Here in this part of work only the common species as per the flora studied has been reported with the understanding that migration

of all these species, mentioned, took place earlier from the region of study to the corresponding world-wide botanical region or vice versa and needs further investigation.

During investigation different species which are common to different botanical regions in the world have been represented under different heads avoiding further detailed work on their nativity.Though information on the origin of some of the species are available but information in connection with most of the species are lacking. That is why various species common to different geographical regions are taken into consideration.

The following species which are commonly distributed in Mirik and its environs and which are Neotropical in origin (Babu, 1977; Hara et al., 1978, 1979, 1982; Martin& Hutchins, 1980-1981; Sharma & Pandey, 1984; Guha Bakshi, 1984) are as follows :

Ageratum conyzoides, Axonopus compressus, Borreria alata, Calceolaria gracilis, Cassia occidentalis, C. tora, Cestrum aurantiacum, C. diurnum, C. elegans, C. nocturnum, Chenopodium ambrosioides, Cissampelos pariera, Conyza bonariensis, C. canadensis, Crotalaria pallida, Datura stramonium, D. suaveolens, Eclipta alba, Erigeron karvinskianus, Eupatorium adenophorum, E. odoratum, Euphorbia hirta, Galinsoga parviflora, Heliotropium indicum, Ipomoea purpurea, Jatropha curcas, Lantana camara, Mimosa pudica, Nicandra physalodes, Nicotiana plumbaginifolia, Oxalis corymbosa, O. latifolia, Paspalum conjugatum, Peperomia pellucida, Physalis minima, P. peruviana, Solanum torvum, S. viarum, Solidago canadensis, Stachytarpheta jamaicensis, Tridax procumbens, Zephyranthes carinata.

Commonly cultivated species in the region and which are Neotropical in origin are as follows :

Agave americana, Capsicum frutescens, Duranta repens, Lycopersicon lycopersicum, Solanum tuberosum, Gomphrena globosa, Helianthus annuus,

Tegetes patula, Zea mays, Zinnia elegans etc. These observations are supported by Bailey (1949), Hara et al. (1978, 1979, 1982), Sharma & Pandey (1984) and Guha Bakshi (1984).

Some common European species (Bentham & Hooker, 1924; Tutin et al., 1964 & 1968) available in the region are as follows :

Bromus ramosus, Chrysanthemum leucanthemum, Oxalis corniculata, Sonchus oleraceus, Stellaria media, Trifolium repens etc.

The cultivated species of European origin are :

Antirrhinum majus, Avena sativa, Bellis perennis, Calendula officinalis, Daucus carota, Iberis amara, Viola tricolor. These species have been regarded by Sharma & Pandey (1984) as European in origin but now-a-days naturalized in this area under observation.

According to several authors (Oliver et al., 1868-1934; Fawcett & Rendle, 1910-1936; Bews, 1918; Hutchinson & Dalziel, 1954, 1958, 1963; Saldanha & Nicolson, 1976; Hara et al., 1978, 1979, 1982; Sharma & Pandey, 1984) the following species are Palaeotropical in origin and have been noted to be common in the region :

Arthraxon lancifolius, Asparagus racemosus, Bulbostylis barbata, B. densa, Cyanotis cristata, Cyperus difformis, C. iria, Dichanthium parviflorum, Digitaria longiflora, Dioscorea bulbifera, Diplocyclos palmatus, Dolichos trilobus, Drymaria diandra, Echinochloa colonum, Eleusine indica, Emilia sonchifolia, Eragrostis gangetica, Euphorbia prostrata, Hydrocotyle sibthorpioides, Imperata cylindrica, Kyllinga brevifolia, Lecanthus peduncularis, Lindernia crustacea, Mariscus sumatrensis, Mukia maderaspatana, Paspalum distichum, Pycreus sanguinolentus, Rubia manjith, Saccharum spontaneum, Schoenoplectus mucronatus, Setaria glauca, S. verticillata, Urena lobata, Utricularia striatula, Vernonia cinerea and a few other species.

The cultivated species of Palaeotropical origin have been noted to be : Lablab purpureus, Linaria bipartita, Ricinus communis, Tegetes erecta etc.

While studying the flora of Mirik and its environs the following species have been noted to be common with the flora of China (Bretschneider, 1882; Forbes & Hemsley, 1888-1905; Merrill & Metcalf, 1937; Merrill & Chun, 1940; Cox, 1945) and Japan (Kanai, 1963; Hara, 1966, 1971; Numata, 1974; Ohashi, 1975; Hara et al., 1978, 1979 & 1982) : Achyranthes bidentata, Acorus calamus, Aeginetia indica, Alnus nepalensis, Anaphalis margaritacea, Artemisia dubia, A. indica, A, japonica, Boenninghausenia albiflora, Calanthe tricarinata, Carex cruciata, C. nubigena, Carpesium abrotanoides, Cerastium fontanum, Conyza japonica, Cryptomeria japonica, Cynoglossum lanceolatum, C. zeylanicum, Desmodium podocarpum, Duchesnea indica, Elsholtzia ciliata, Ficus sarmentosa, Geranium nepalense, Gnaphalium hypoleucum, Goodyera foliosa, G. repens, Gynostemma pentaphyllum, Herminium lanceum, Hypericum japonicum, Hypoxis aurea, Juncus leschenaultii, Mazus pumilus, Microstegium nudum, M. vimineum, Morus australis, Muhlenbergia huegelii, Pimpinella diversifolia, Pogonatherum crinitum, Polygonum chinense, P. nepalense, Polypogon fugax, Quercus glauca, Rhus javanica, R. succedanea, Rhynchospermum verticillatum, Rotala rotundifolia, Smithia ciliata, Spiranthes sinensis var. amoena, Sporobolus fertilis, Streptolirion volubile, Swertia bimaculata, Symplocos paniculata, Torilis japonica, Viola biflora, V. diffusa, Youngia japonica etc.

Some of the species observed in the region have been noted to be similar with the flora of Malaya (Ridley, 1922; van Steenis, 1948-1986; Holttum, 1957). These are : Aclisia secundiflora, Amischophacelus axillaris, Aneilema scaberrima, Arthraxon quartinianus, Borreria articularis, Buddleja asiatica, Carex baccans, C. filicina, Chonemorpha fragrans, Clematis smilacifolia, Clerodendrum viscosum, Commelina maculata, C. paludosa, Crotalaria bialata, Croton caudatus, Cuscuta reflexa, Cymbidium lancifolium, Debregeasia longifolia, Dendrobium eriiflorum, Dichroa febrifuga, Elaeagnus conferta, Elsholtzia blanda, Euodia fraxinifolia, Eurya acuminata, Exbucklandia populnea, Festuca leptopogon, Ficus semicordata, Fimbristylis falcata, Garnotia stricta, Gastrochilus calceolaris, Globba marantina, Glycosmis arborea, Gouania tiliaefolia, Helixanthera parasitica, Laportea terminalis, Lepidagathis incurva, Leucas mollissima,

Lindernia procumbens, Liparis nervosa, Lonicera acuminata, Lyonia ovalifolia, Mahonia acanthifolia, Mariscus cyperinus, Melastoma normale, Melissa axillaris, Mosla dianthera, Murdannia spirata, Mussaenda macrophylla, Mycetia longifolia, Neillia thyrsiflora, Paederia foetida, Panicum psilopodium, Perilla frutescens, Persea odoratissima, Polygala arillata, Polygonum posumbu, Pothos scandens, Pouzolzia sanguinea, P. zeylanica, Pratia nummularia, Prunus undulata, Pycreus diaphanus, Reinwardtia indica, Rubus ellipticus, R. lineatus, R. rosifolius, Sanicula elata, Scurrula parasitica, Shuteria vestita, Sopubia trifida, Stellaria vestita, Trichosanthes wallichiana, Valeriana hardwickii, Veronica javanica, Viscum articulatum, Vitex negundo, Zanthoxylum acanthopodium and many other species.

Besides, a good number of plants have been observed in the region and which are common to the flora of South-East Asia (Loureiro, 1790-1793; Kurz, 1877; Craib, 1925; Kanjilal et al., 1934-1940; Bor, 1960; Backer & Bakhuzen van den Brink, 1963 - 1968; van Steenis, 1972; Rao, 1974; Trimen, 1974-1984; Dassanayake, 1983). These are as follows : Acer oblongum, Achyrospermum densiflorum, Aeschynanthus acuminatus, Agrostophyllum callosum, Ainsliaea latifolia, Anaphalis adnata, Apluda mutica, Argostemma verticillatum, Arisaema consanguineum, Arundinella bengalensis, A. nepalensis, Asparagus filicinus, Begonia palmata, Beilschmiedia roxburghiana, Brassaiopsis glomerulata, Bulbophyllum wallichii, Caesalpinia cucullata, Camellia kissi, Castanopsis hystrix, C. indica, C. tribuloides, Celastrus hookeri, Chirita macrophylla, C. pumila, Clematis buchananiana, Clerodendrum colebrookianum, Coelachne simpliciuscula, Craniotome furcata, Crotalaria albida, Debregeasia wallichiana, Dendrocalamus hamiltonii, Desmodium multiflorum, D. sequax, Dicentra scandens, Dichanthium assimile, Digitaria cruciata, D. setigera, Dioscorea kamoonensis, Disporum cantoniense, Eragrostis unioloides, Eulaliopsis binata, Euodia lunu-akenda, Ficus auriculata, F. obligodon, Galium elegans, Gerbera piloselloides, Gynura cusimbua, Hedyotis scandens, Helicia nilagirica, Hemiphragma heterophyllum, Hydrangea robusta, Hymenopogon parasiticus, Indigofera stachyodes, Inula cappa, I. eupatorioides, Isachne albens, Ligustrum confusum, Lindera pulcherrima, Lithocarpus elegans, Litsea cubeba, Lobelia pyramidalis, Loxostigma griffithii, Mallotus philippensis, Mucuna macrocarpa, Neanotis calycina, Oenanthe javanica, Ornithochilus difformis, Parochetus communis, Photinia integrifolia, Pogonatherum paniceum, Polygala crotalarioides, Porana racemosa, Rabdosia coetsa,

R. lophanthoides, Rhaphidophora decursiva, Saussurea deltoidea, Schoenorchis gemmata, Scutellaria discolor, Senecio scandens, S. triligulatus, Smilax lanceifolia, S. perfoliata, Symplocos dryphila, S. glomerata, S. racemosa, S. sumuntia, Thysanolaena maxima, Vaccinium dunalianum, Vernonia volkameriifolia, Viburnum cylindricum, Viola pilosa, Zanthoxylum nitidum etc.

Some other species also observed in the region under study have been noted to be similar with the flora of Central and West Asia (Ruprecht, 1869; Maximowicz, 1889; Kitamura, 1960, 1964; Zohary, 1962, 1966; Rechinger, 1963-1976; Davis, 1965-1975; Guest,1966). These are : Avena fatua, Clinopodium umbrosum, Conyza stricta, Cynoglossum glochidiatum, Fagopyrum esculentum, Hypoestes triflora, Indigofera linifolia, Jasminum humile,Lactuca dissecta, Urtica dioica etc.

At the same time few other species available in the region are to be mentioned below and which are similar to the flora of Australia (Bentham & Mueller, 1863-1878) : Alloteropsis semialata, Bidens biternata, Brachiaria distachya, Celastrus paniculatus, Chrysopogon aciculatus, Dendrophthoe falcata, Drosera peltata, Eulalia leschenaultiana, Fimbristylis schoenoides, Hedyotis auricularia, Iphigenia indica, Lindernia ciliata, Melastoma malabathricum, Potamogeton crispus, P. octandrus, Rubus moluccanus, Smithia sensitiva, Trichosanthes tricuspidata, Vigna vexillata etc.

It is very interesting to note that some of the Pantropical species that is those species which are common to three tropical sectors of the world, namely, America, Africa and Asia-Australasia, are common to this region and the percentage has been calculated to become 9%. Such species are : Achyranthes aspera, Adenostemma lavenia, Amaranthus spinosus, Bidens pilosa, Capsella bursa-pastoris, Cerastium glomeratum, Cleome gynandra, Colocasia esculenta, Cyperus compressus, C. diffusus, C. rotundus, Dichanthium annulatum, Digitaria sanguinalis, Drymaria villosa, Fimbristylis dichotoma, F. miliacea, Gnaphalium luteo-album, Kyllinga nemoralis, Mariscus aristatus, Murdannia nudiflora, Oplismenus burmannii, O. compositus, Paspalum scrobiculatum, Peperomia tetraphylla, Plantago erosa, Poa annua, Pseudechinolaena polystachya, Pycreus pumilus, Sida acuta, S. rhombifolia, Siegesbeckia orientalis, Solanum nigrum. Pantropical distribution for all other have already been mentioned in

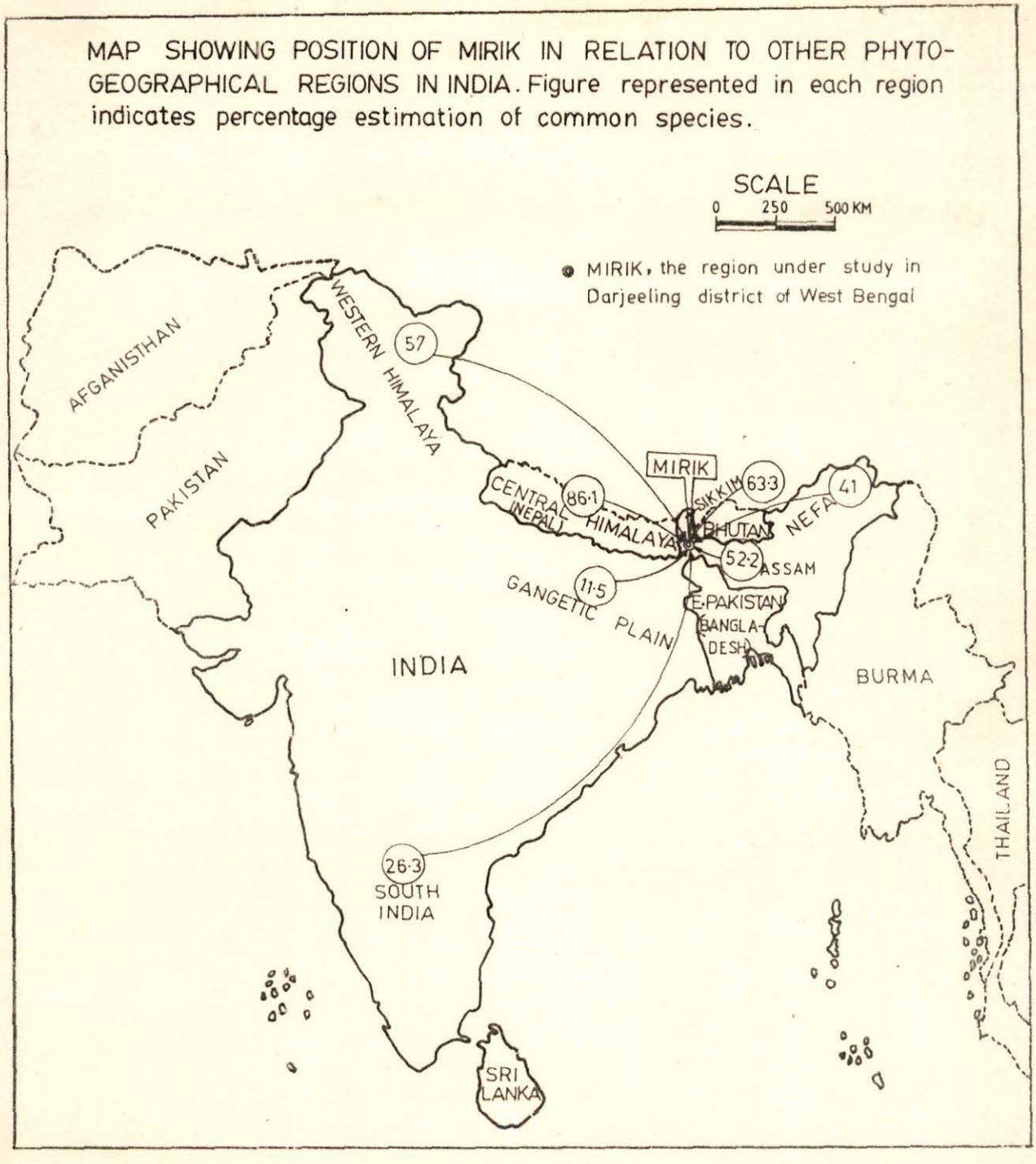
MAP SHOWING POSITION OF MIRIK IN RELATION TO OTHER PHYTO-GEOGRAPHICAL REGIONS IN INDIA. Figure represented in each region indicates percentage estimation of common species.
SCALE
0 250 500 KM
MIRIK, the region under study in Darjeeling district of West Bengal
AFGANISTHAN
PAKISTAN
WESTERN HIMALAYA
57
MIRIK
CENTRAL HIMALAYA (NEPAL)
86·1
SIKKIM
63·3
41
NEFA
BHUTAN
52·2
ASSAM
11·5
GANGETIC PLAIN
E. PAKISTAN (BANGLA-DESH)
INDIA
BURMA
THAILAND
26·3
SOUTH INDIA
SRI LANKA

Fig. 62.

Part II under the heads of Geographical distribution of respective species. These observations are supported by Good (1964), Hara (1966, 1971), Ohashi (1975) and Hara et al. (1978, 1979, 1982).

TABLE - XII

Compilation of percentage occurrence of different species (excluding cultigens) observed in Mirik and its environs and common to different region in the Himalaya, Gangetic Plain and South India.

Western Himalaya	Central Himalaya (Nepal)	Eastern Himalaya			Gangetic Plain	South-India
		Sikkim	Bhutan	NEFA including Upper Assam (North-East Himalaya)		
57.0	86.1	63.3	52.2	41.0	11.5	26.3

Table XII suggests that 86.1% species of the region under study is common to that of Nepal (Banerjee, 1954, 1965, 1966, 1968, 1969; Kihara, 1955; Banerje & Thapa, 1969-1973, 1976; Stainton, 1972; Hara et al., 1978, 1979, 1982). Besides, common species of Bhutan (Balakrishnan & Choudhury, 1966, 1967; Deb et al., 1968; Subramanyam, 1973; Balakrishnan, 1978; Grierson & Long, 1983, 1984,1987) and Sikkim (Gammie, 1894a & 1894b ; King & Pantling, 1898; Smith, 1913b, Bruhl, 1926; Tobin, 1930; Biswas & Townend, 1936; Ghose, 1951-1957; Biswas, 1956, 1966; Sain, 1958, 1959; Sharma & Ghosh, 1970) have been noted to be 52.2% and 63.3% respectively. Moreover, different elements of the region common to Western Himalaya (Collett, 1902, Kashyap, 1925; Rau, 1975; Babu, 1977; Mani, 1978; Rao & Verma, 1979; Chowdhery & Wadhwa, 1984) and North-East Himalaya (Kanjilal et al., 1934-1940; Srinivasan, 1959) represent 57% and 41% respectively (Fig. 62). Thus it is obvious that the flora of Mirik and its environs is basically similar to that of Nepal. According to Chatterjee (1939, 1960), the region of Nepal only has been represented as Central Himalaya due to its characteristic flora as compared to those of Western and Eastern Himalaya. It has been noted in the Table XII the elements of the region under study is quite dissimilar in comparison to that of Western and North-East Himalaya. Thus it is justified that the Mirik and its environs should also

be incorporated under the botanical region of Central Himalaya and it is quite probable that as the region under study is situated from Geographical point of view just as the border line of Eastern Nepal their floristic similarity is very much expected.

Moreover, the Table XII also suggests that the species common to the flora of Bengal Plains (Prain,1903; Guha, 1971; Jain et al., 1975; Bennet, 1979; Paria & Sahoo, 1980; Guha Bakshi,1984; Mukhopadhyay, 1987) situated in the south of the region under study and to that of extreme South India (Gamble & Fischer, 1915-1936; Mayuranathan,1929; Ramaswamy & Razi, 1973; Saldanha & Nicolson, 1976; Matthew, 1981-1983; Nair & Henry, 1983; Sharma et al., 1984) represent 11.5% and 26.3% respectively. The causal factor of the distribution of the discontinuous species of South India to the region under study is yet to be worked out.

In order to provide a theoretical explanation of the geography of the flowering plants, Good (1931) proposed the Theory of Tolerance, the main principles of which are (a) plant distribution is primarily controlled by the distribution of climatic conditions and is secondarily controlled by the distribution of edaphic factors, (b) Great movements of species and of floras have taken place in the past and are apparently still continuing and is brought about by the transport of individual plants during their dispersal phases.

Although the paper enunciating the Theory of Tolerance and discussing its application to problems of plant geography appeared only in 1931, the conception on which the theory was based was implicit at least in many earlier writings pointed out by Wulff (1932, 1943). Some other writers have expressed themselves even more definitely. Thoday (1925) says, "the distribution of the species ..... indicates that each has a distinct physiological constitution and is specialized to a definite range of environmental factors". Salisbury (1926), in a paper, makes frequent and direct allusion to the conception of tolerance, actually employing the phrase "climatic tolerance".

Another noteworthy reference to tolerance is that of Hutchinson (1918) in a paper with the significant title "Limiting factors in relation to specific

tolerance of forest trees". He refered to the statement of Schimper (1903-1904) that " the differentiation of the earth's vegetation is thus controlled by three factors - heat, atmospheric precipitation (including winds) and soil. Heat determines the flora, climatic humidity the vegetation; the soil as a rule merely picks out and blends the material supplied by these two climatic factors, and on its own account adds a few details".

In the previous discussion in Part I of the thesis in connection with the ecological observations, it is mentioned that rainfall in the region under study has been decreased to a considerable amount during the last over hundred years (Tables I & II). As a result, marked effect on vegetation and the flora has been intensely noticed. Most of the "Jhoras" and water streams remain in drying condition over a considerable period of time in a year. And for this reason tropical plants have been observed to be adapted in the setup of climatic change. Once the European and North American species were predominant accompanied by very small amount of African tropical species (Hooker, 1854; Banerjee et al.,1980), now-a-days is being replaced by major percentage of Malaysian elements of 21% as compared to only 4% reported earlier. Besides, Pantropical species of 9% indicates the predominance of tropical climate day by day in the region under study.

According to Good (1964), in the matter of plant geography temperature is more fundamental than rain but in the matter of plant ecology, from the point of view of vegetational development rain is more important than heat. As there is an intimate relation between temperature and rainfall because of the influence of the former having a role on the determination of humidity of the air and thereby the effectiveness of the precipitation, there is no doubt that all these climatic factors are responsible to control the composition of the taxonomic units of a flora from phytogeographical point of view. Or in other words, the evolution of floras depends upon plant migration, the evolution of species, and the selective influences of climatic change acting upon the varying tolerances of the component species. That evolution of flora is still being operative due to environmental pressure is well reflected during analysis showing order of dominance of angiosperm families (Table VIII) as compared to

the observation noted earlier by other workers (Prain, 1903; Hooker, 1904) who noted different order of dominance of families in earlier days.

The most interesting observation has been made in connection with the family Fabaceae Lind. (Leguminosae Juss. vel Papilionaceae Giseke, nom. alt.) which has a great role on the upliftment of the fertility status of the soil in the region. Previously about 100 years back the position of the family was higher due to accumulation of large number of taxa within it, but in recent years due to deterioration of the soil in the region and due to highly acidic pH of the soil Leguminous species are becoming rare in the region.

During the last eighty years (1901-1981) the human population of the region has increased tremendously (Fig. 11). This increase in population coupled with the increased demand on natural forest areas for cultivation of agricultural and horticultural crops and for fuel, forest areas are being destroyed at a greater pace, year after year. Similarly, increased communication even with remote villages by new road connections etc., facilitates more movement of people from outside and consequently more interference with the vegetation and flora of the region occurs. As a result, man has enormously and recklessly modified and degraded the ecosystem of the region. Such degraded ecosystem has developed into several types of secondary vegetation as shown in Part I under vegetation types, constituting new structure of the flora.

SUMMARY

After consulting different floras, monographs, journals and various other literature supported by different authentic herbarium specimens in India and abroad, available in different herbarium sections, plant elements of the region under study have been studied from phytogeographical point of view.

Percentage occurrence of species common to different botanical regions in the world has been prepared, of which Chinese (42%), Japanese (13%), Malaysian (21%), S.E. Asian (73%) and C. & W. Asian (16%) elements are remarkable. Enumeration of different species according to Neotropical and

Palaeotropical in origin has been made. Besides, members of Pantropical area of distribution have been pointed out.

Percentage occurrence of various species common to different botanical regions in India has been worked out in details. Out of the study the Flora of Mirik and its environs is very much similar to that of Central Himalaya (Nepal) by 86.1% as against Western Himalaya (57%), Sikkim (63.3%), Bhutan (52.2%), NEFA including Upper Assam (41%), Gangetic Plain (11.5%) and S. India (26.3%).

On the basis of much similarity of flora between Nepal and the region under study, Mirik and its environs has been suggested to be included within the botanical region of Central Himalaya, established previously by D. Chatterjee (1939, 1960) who considered Nepal only to represent as Central Himalaya.