

PHYTOGEOGRAPHIC CONSIDERATIONS ON THE FLORA OF MT. ABU*

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ABSTRACT

The Aravallis intersect the State of Rajasthan in a southwest-northeast direction. Mt. Abu on the Aravallis is the highest point in the wide gap between the Himalayas and the Nilgiris, and thus has phytogeographic significance. The flora of Mt. Abu has been compared with that of other hilly regions of India, and also with the flora of adjacent regions of the dry zones. It is observed that :

- i. the flora of Mt. Abu has some representation of mountain element belonging to subtropical and temperate regions of India. This element comprises three groups of plants, namely, (a) those occurring in all or most hilly regions of India, such as in Himalayas, Parasnath, Pachmarhi, Western Ghats, Nilgiris, etc. (26 species); (b) plants found in the Himalayas or moist places of northern India, whose southern limit is the Mt. Abu (19 species); and (c) plants found in the Ghats and hills of Deccan Peninsula and whose northern limit of distribution is Mt. Abu (38 species).

- ii. there are only a few plants of alpine regions in this flora;
- iii. large number of plants are of wide general distribution;
- iv. biotic factors are resulting in increase of xerophytic species on this hill.

A study of the world distribution of the plants of Mt. Abu shows that:

- i. out of 469 species, 267 are tropical;
- ii. 80 species are eastern, southeastern, Asian and Australian;
- iii. 46 species are African-Arabian; and
- iv. 22 species are American. The American plants are mostly weeds of cultivation.

INTRODUCTION

Mt. Abu is a well known hill station of India situated in $24^{\circ}36'$ N and $72^{\circ}43'$ E in Rajasthan. It is a part of the Aravalli hill range, though separated from the main range by a narrow valley. The hill is approachable by a nice, motorable, all-weather road (about 30 km) from Mt. Abu railway station on the Ahmedabad-Delhi line. The name Abu is said to be derived from *Arbudha*, 'the hill of wisdom'. The highest point Gurushikhar hill stands 1722 m high.

The natural features of Mt. Abu are very bold, and the slopes, particularly on the western and northern sides, are precipitous; on the east and south the outline is broken by spurs and valleys. These are densely wooded.

Due to its altitude and high rainfall, Abu has the richest vegetation in whole of Rajasthan. The forests on lower slopes and bases of hills have trees commonly met with in the adjacent plains and lower ranges of Aravallis.

The upper slopes and valleys are densely wooded with rich subtropical evergreen forest, having *Mangifera*, *Erythrina*, *Kydia*, *Albizia*, *Mallotus*, *Syzygium*, *Anogeissus*, *Ficus*, etc. The plant communities found at Mt. Abu are not seen elsewhere in Rajasthan.

Mt. Abu attracts large number of visitors from all over India and even from abroad. The population of the small town swells up in summer, causing pressure on the forest resources of the region. Protection of the forest cover on this hill is very important, as the denudation of the hill is making the habitat unsuitable for the rich flora and vegetation that it can otherwise support.

Mt. Abu, like other hill stations, attracted several botanical explorers since the middle of the last century. Short accounts of the flora have been published by several workers. The present author (Jain 1962) reviewed the work done on the botany of Mt. Abu and published a list of 469 plants from this hill. This work was based on collections made in different seasons from 1956 to 1960. The factors affecting the flora and vegetation are discussed therein.

Since preparation of the present work, Kanodia and Deshpande (1961) and Kanodia and Rao (1965, 1966) have reported some additional species from this region.

No work has, however, been done on the phytogeographic relationship of the flora of this hill. The present work, therefore, lays emphasis on this aspect of the flora of Mt. Abu. An analysis of the component species, with regard to their world

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distribution, has been attempted. The flora has been compared with the flora of other regions in India, as well as, with the flora of some adjacent countries.

The suggestion that Mt. Abu acts as a meeting ground for the different elements of flora has been examined in the light of an analysis of these comparisons. The role of Mt. Abu in the entry of foreign temperate plants into India has been discussed with some examples.

The object was, to find out, firstly, the proportion of those plants which occur only at higher altitudes in India, (approximately above 1000 m) referred now as 'mountain element', and those plants which occur generally on plains, or the 'plain element' in the flora of Mt. Abu, and secondly, to study the composition of flora from the view-point of its origin.

The following aspects were studied:

(1) Comparison of the flora of Mt. Abu with the flora of adjacent areas in Aravallis, namely the north-eastern lower Aravallis.

(2) Relationship with other neighbouring regions, such as Rajasthan, Saurashtra and the Upper Gangetic Plains.

(3) Relationship with other mountainous regions of India, such as the Himalayas in North, Parasnath hill in Bihar, Pachmarhi hill in Central India, the Western Ghats at Khandala and Mahabaleshwar, and the hills of South India (the Nilgiri and Pulney hills).

(4) Relationship of the flora of Mt. Abu with the flora of certain other parts of world, to study the influence of the western, temperate, xerophytic and the Indo-Malayan elements, and to evaluate the suggestion made by Drude (1890, 1913), Blatter and Hallberg (1918-1921), and Biswas and Rao (1953), that the Aravallis and northwestern Rajasthan are the boundary line and the meeting place of these elements.

According to availability of the literature on the flora of the Himalayas, the region was divided into four, namely the Outer Himalayas, the Middle Himalayas, the Inner Himalayas, and the Siwalik mountains.

RELATIONSHIP WITH INDIAN FLORA

Comparison with lower Aravallis

In order to appreciate the effect of altitude on the flora of Mt. Abu, the flora was compared with that of the north-eastern ridges of the Aravallis, which

have much lower altitude. Botanical lists and notes on the vegetation of this north-eastern region, (i.e., lower Aravallis) have been prepared by several workers, e.g., by Ratnam (1951) for Lohargal, Mukherjee (1953) for Delhi ridge, Bakshi (1954) for Pilani, Nair and Nathawat (1956, 1957) for Pilani and Harshnath Hills, Nair and Kanodia (1959) for Ajit Sagar Bundh, and by Sharma (1958) for Ajmer.

A comparison with the vegetation of Harshnath is first discussed. This hill, on the north-eastern end of the Aravalli Range is, next to Mt. Abu, one of its highest peaks; the altitude at top is about 1000 m. The vegetation of the surrounding plain country, the slopes and the hill tops has been described by Nair and Nathawat (1957). The vegetation is greatly disturbed, and is in degraded stage. The vegetation and flora are not much different from the flora of low hillocks or rocky plains. There is no similarity with the characteristic flora and vegetation of higher regions of Mt. Abu. The forests at Mt. Abu are Subtropical Evergreen forests, and are characterized by the presence of *Syzygium cumini*, *Mangifera indica*, *Crateva nurvala*, *Flacourtia indica*, *Bauhinia purpurea*, *Mallotus philippensis*, *Boswellia serrata*, *Lannea coromandelica*, *Sterculia urens*, *Carissa opaca*, *Jasminum humile*, *Rosa moschata*, *R. involucrata*, *Carvia callosa*, *Girardinia zeylanica* and the orchid, *Aerides crispum*.

The plant communities at Mt. Abu have frequent occurrence of *Erythrina* spp., *Albizia* spp., *Emblica officinalis*, *Trema orientalis*, *Kydia calycina* and, a dominance of *Carissa* and *Carvia* shrubs all over the mount.

Not even one species from the above list is mentioned by Nair and Nathawat (loc. cit.) from Harshnath. Further, the spots where most luxuriant vegetation could be expected at Harshnath are described by Nair as, 'at the highest point there are a few artificial ponds in which were seen *Lemna*. Around these ponds the soil supports a thick growth of *Bambusa*, *Anogeissus*, *Holoptelea*, *Salvadora*, *Acacia*, *Prosopis*, and shrubs such as *Zizyphus xylopyra*, *Capparis decidua* ...'. The reference of thick growth of *Prosopis* and *Capparis decidua* is significant; it shows the stage at which the vegetation of this hill is arrested at present. The vegetation and flora of Harshnath, therefore, have no similarity with the characteristic subtropical flora of Mt. Abu, and common elements of the two hills are only those species which are either marginal in distribution or have a wide range of distribution,

such as *Adhatoda vasica*, *Argemone mexicana*, *Calotropis* sp., *Cassia tora*, *Cocculus hirsutus*, *Grewia tenax*, etc.

More than 250 species recorded from Mt. Abu have not been reported from any of the localities on the lower ranges of Aravallis from Ajmer to Delhi ridge. Some of the lower north-eastern Aravallis are under exploration by workers at Pilani, Jodhpur, etc., and this intensive exploration of this region may cover up some of the gap of this dissimilarity. But it is evident that Mt. Abu has a number of plants not found in the surrounding lower regions, even on the same range of Aravallis. This can be attributed to the higher altitude at Mt. Abu.

Comparison with north-western Rajasthan

Only 119 plants are common with the dry tract of north-western Rajasthan. These plants are mostly those species which have a very wide range of distribution and occur, often, in India from sea level to about 1000 m and in subtropical regions. They are generally weeds of cultivation or plants growing near aquatic habitats.

Butea monosperma, *Cardiospermum halicacabum*, *Cleome viscosa*, *Cocculus hirsutus*, *Zizyphus mauritiana*, *Acacia nilotica*, *Tridax procumbens*, and *Calotropis procera* are among the plants of wide general distribution.

Argemone mexicana, *Polygala erioptera*, *Cassia auriculata*, *Ageratum conyzoides*, *Echinops echinatus*, *Alternanthera sessilis* and *Amaranthus* species are some of the weeds common to Mt. Abu and north-western Rajasthan.

Tamarix sp., *Oxalis corniculata*, *Glinus lotoides*, *Verbascum chinense*, *Potamogeton crispus*, *P. pectinatus*, and *Saccharum spontaneum* are among the species occurring in Mt. Abu and north-western Rajasthan near aquatic habitats.

An examination of these plants, common between north-western Rajasthan and Mt. Abu, indicates that the xerophytic element in the flora of Mt. Abu is increasing and plants from surrounding desertic or sub-desertic tracts are invading the mount.

The following plants, characteristic of warmer and drier habitats, are found at Mt. Abu:

**Alysicarpus procumbens*, *Cassia auriculata*, **Cleome viscosa*, **Commelina forskalaei*, **Corallocarpus epigaeus*, **Dipteracanthus patulus*, *Grewia damine*, *G. villosa*, *Maytenus emarginata*, **Sida spinosa*, **Triumfetta rotundifolia*, **Zizyphus nummularia*. Of these, the species marked with asterisk (*)

have been reported from Mt. Abu only very recently. On the contrary, none or few temperate or alpine plants have been reported of recent (*Ranunculus sceleratus* reported by Jain, 1962).

The xerophytic element in the flora of Mt. Abu is discussed in detail in later pages.

Comparison with Saurashtra

The flora of Saurashtra has been described by Santapau (1953, 1962) and Santapau and Raizada (1954). Among the different areas compared with Mt. Abu, Saurashtra has the highest number of plants (278) in common with the mount.

Gir forest in Saurashtra is a protected area and a number of plants, which are not found in surrounding plain country, grow there, e.g. *Desmodium rotundifolium*, *Dioscorea pentaphylla*, *Hemigraphis latebrosa*, *Abelmoschus ficulneus*, *Lindernia parviflora*. Proximity of Saurashtra to Mt. Abu might also account for this resemblance in flora.

There are some plants which are found in the Deccan Peninsula and their northern limit of distribution is Mt. Abu. Some such plants contribute to the common flora of Saurashtra and Mt. Abu, e.g. *Abelmoschus manihot*, *Carvia callosa*, *Eranthemum roseum*, etc. Such plants are discussed in further pages.

Comparison with Khandala Ghats

The chain of hill ranges of the Western Ghats are an important topographical unit in western India. The flora of Khandala on Western Ghats has recently been intensively studied by Santapau (1960). The average altitude of Khandala is 677 m above sea level but the highest hill, the Bhoma Hill, is 848 m (2782 ft.). The altitude is much lower compared with Mt. Abu, but the situation of Khandala on the edge of the Ghats is particularly favourable for heavy rainfall. The average annual rainfall is about 5000 mm (195 inches). (Mt. Abu has annual rainfall of 1750 mm or 70 inches).

There is striking resemblance in the flora of two regions and out of 467 species, occurring at Mt. Abu, 270, i.e., about 58 percent, are found in Khandala.

The most remarkable are those plants which occur in Western Ghats and Mt. Abu and whose northern limit today is Mt. Abu, e.g. *Atylosia sericea*, *Barleria cuspidata*, *Canthium dicoccum*, *Carvia callosa*, *Cyperus flavescens*, *Senecio grahami*, *Smithia bigemina*, etc.

Comparison with south Indian hills

Gamble (1915-36) described the flora of Madras, covering large parts of southern India. Fyson (1915) studied the flora of Nilgiri and Pulney hill tops (above 2000 m) in south India. Fyson remarked: 'out of the 500 species described, 430 are considered indigenous. Of these, 44, i.e., more than 10 percent, are known only from Nilgiris. Another 17 percent occur on the Khasi hills, 2500 km away; and about 12 percent on the temperate parts of the Himalayas, but practically none at all in all the intervening country, even along the Western Ghats'.

A comparison between the flora of Mt. Abu, and Nilgiri and Pulney hill tops reveals that Fyson's statement (about absence of his plants in the gap between Nilgiris and Himalayas) has to be modified. 39 species of the Nilgiri and Pulney hill tops, i.e., 8 percent occur in Mt. Abu. Most of these 39 species were reported from Mt. Abu earlier than Fyson's work. *Ageratum conyzoides*, *Cassia mimosoides*, *Celastrus paniculata*, *Conyza stricta*, *Emilia sonchifolia*, *Indigofera pulchella*, *Linum mysorens*, *Nicandra physaloides*, *Oxalis corniculata*, etc. were reported from Mt. Abu by Macadam as early as 1890. Some such common species, e.g. *Bidens biternata*, *Centella asiatica*, *Coronopus didymus* and *Galinsoga parviflora* have been reported by Jain (1962) only recently.

Razi (1955) studied the flora of Mysore hill tops, and reported some plants which are common with Mt. Abu, e.g. *Aerva sanguinolenta*, *Artemisia parviflora*, *Campanula canescens*, *Polygala persicariaefolia*, and *Viola patrini*.

An examination of the plants common with Saurashtra, Western Ghats and South Indian hills reveals that the flora of Mt. Abu includes some plants for which this hill is approximately the northernmost boundary in India. These plants are found only in Deccan Peninsula, usually on Ghats, and extend northwards only upto Mt. Abu. They are not found in Himalayas. These can be called the *Peninsular Mountain Element* with the following species:

Abelmoschus manihot, *Adhatoda beddomei*, *Aerides crispum*, *Aglaia odoratissima*, *Anisochilus eriocephalus*, *Atylosia sericea*, *Barleria cuspidata*, *Begonia trichocarpa*, *Canthium dicoccum*, *Carvia callosa*, *Capparis pedunculosa*, *Centratherum phyllolaenum*, *Ceropegia hirsuta*, *Crotalaria trifoliatum*, *C. triquetra*, *Cyperus brevifolius*, *C. flaves-*

cens, *C. leucocephalus*, *C. metzii*, *Dyerophyton indicum*, *Eranthemum roseum*, *Eulophia bracteata*, *Euphorbia pycnostegia*, *Grewia flavescens*, *G. rhamnifolia*, *Helixanthera obtusata*, *Ipomea wightii*, *Ischaemum impressum*, *Jasminum rotlierianum*, *Nepeta bombaiensis*, *Rotala mexicana*, *Senecio grahamei*, *S. saxatilis*, *S. lavandulaefolius*, *Smithia bigemina*, *S. capitata*, *Trachispermum stictocarpum* and *Wagatea spicata*.

Comparison with Pachmarhi in Madhya Pradesh

The flora of Madhya Pradesh hill tops has been studied by Rao and Narayanaswami (1960) and Maheshwari (1960). Rao and Narayanaswami have described the vegetation and flora chiefly of Pachmarhi, but have referred also to the plants of Chhindwara, Betul and Khandwa. Maheshwari has described the vegetation of Asirgarh hills.

The average altitude of Pachmarhi is 1067 m but the prominent peaks, such as Mahadeo Hill, Chouradeo and Dhupgarh are higher. Their altitudes are, Dhupgarh, 1350 m (4429 ft.); Mahadeo Hill, 1328 m (4358 ft.); Chouradeo, 1312 m (4303 ft.).

The highest altitude in Madhya Pradesh, therefore, is 1350 m, about 400 m lower than Mt. Abu. Only 140 species (i.e., 30 percent) of Mt. Abu flora are common with Pachmarhi. Most of these common elements are plants of wide general distribution in India, e.g. *Cissampelos pareira*, *Cocculus hirsutus*, *Argemone mexicana*, *Rorippa indica*, *Kydia calycina*, *Salmalia malabarica*, *Sida acuta*, *S. rhombifolia*, *Triumfetta rhomboidea*, *Oxalis corniculata*. There is no plant confined only to Mt. Abu and Pachmarhi.

The flora of Pachmarhi, like that of Mt. Abu, does express the effect of altitude; there are plants common to Pachmarhi Hills and Mt. Abu which are restricted to mountain regions only, such as *Berberis asiatica*, *Plectranthus mollis*, *Cyperus imbricatus*, *Artemisia parviflora*, *Spermatidictyon suaveolens*, *Carvia callosa*, *Michelia champaca*, *Barleria dichotoma*, *Indigofera pulchella*, *Moghania strobilifera*, *Sterculia villosa*, *Vigna capensis*.

Comparison with Parasnath hill (Bihar)

A comparison of the flora of Mt. Abu with that of Parasnath Hill in Bihar has also been attempted. The flora of Parasnath has been studied recently by Srivastava (1955) and Bharadwaja (1958). Srivastava has classified the list of plants found on Parasnath in three categories, plants found upto approximately 670 m, plants found from 670 to

1340 m, and plants found above 1340 m. Since the jurisdiction of the list of plants from Mt. Abu has also been kept approximately above 670 m altitude, a comparison has been made with the plants occurring at Parasnath above 670 m. Only 24 species of Mt. Abu are common with Parasnath. This is due to the fact that the tops of the Parasnath Hill are not inhabited by man, and save for the few temples and their visitors, the place is spared from much interference. These 24 species, common between Mt. Abu and Parasnath, are discussed below.

Anisochilus eriocephalus, which is common in Deccan Peninsula, extends in north-west upto Mt. Abu, and in north-east upto Parasnath. It is not found in Himalayas. *Ceropegia hirsuta* has the same distribution. It extends from Deccan to Mt. Abu and Parasnath Hills only. 10, out of these 24 plants, are distributed on hill tops and mountains of India, e.g. *Berberis asiatica*, *Geranium ocellatum*, *Indigofera pulchella*, *Lindernia sessiliflora*, *Reinwardtia indica*. 12 plants are of wider occurrence in India, found almost all over the country, e.g. *Justicia diffusa*, *J. simplex*, *Plumbago zeylanica*, *Siegesbeckia orientalis* and the grass species.

Comparison with Himalayas

It has often times been stated that the flora of Mt. Abu has several temperate climate plants or, precisely, Himalayan plants in its flora. A study of this resemblance of the flora of Mt. Abu with that of the Himalayas, particularly with reference to other hill stations in India, is of phyto-geographical interest.

The Himalayan Range consists of a series of high and low mountains running in parallel chains from Kashmir to Assam. There are great altitudinal and latitudinal variations in the Himalayas and there is no botanical flora for the Himalayas as a whole. Several floras of smaller regions in Himalayas have been written and for the purpose of present study certain spots were chosen from the northern and north-western Himalayas.

In extreme north-west the flora of Tirich Mir and Kashmir has been compared with Mt. Abu flora. For a comparison with the Himalayan ranges of Punjab and Kumaon, the Siwalik region has been taken as a separate unit. Their three, rather arbitrary, zones, the Outer Himalayas, Middle Himalayas and the Inner Himalayas, have been considered. This division is on the consideration of location and altitude. Wadia (1957), chiefly on the

basis of altitude, classified the Himalayas in three zones called 'Great', 'Lesser' and 'Outer' Himalayas, with zones of maximum altitude about 6700 m, 4000-5000 m and 1000-1340 m, respectively. There are no plant lists available so classified for different altitudes. For the purpose of comparison here, the following basis has been adopted:

The Outer Himalayas: The area of the outer hill ranges in Kumaon Hills with an altitude of 1340 to 2000 m has been included. The Mussoorie and Nainital Hills lie in this zone and are also botanically well explored. The plant lists given by Puri and Gupta (1961), Jain (1956) and Raizada (1959) have been referred for this area.

The Middle Himalayas: The hills situated comparatively in the interior ranges and attaining altitudes about 2000 to 3000 m have been included in this zone. Their southern parts usually merge into the outer ranges. The Simla Hills of Middle Himalayas and the hills of Kulu area, also in the middle ranges of Himalayas, have been botanically studied and have been taken for comparison. The plants reported by Collett (1902), Jain and Bharadwaja (1951) and Gupta (1960) were referred for this zone.

The Inner Himalayas: This zone includes further interior ranges of hills, i.e., upto snow-line and glaciers. The altitude ranges approximately from 2670 to 5000 m, though in some valleys it falls down much lower. The flora of these regions is temperate and alpine, but due to localised habitat factors, such as soil and biota, plants typical of lower altitudes also creep into this zone. The flora of Bashahr in Punjab and Milam and Pindari glacier areas in Kumaon Hills have recently been studied and were, therefore, chosen for comparison. The plant lists of Puri (1961) and Rao (1959, 1960) have been referred for this zone.

Comparison with Tirich Mir

The flora of Tirich Mir, the highest peak (altitude 7700 m) in the Hindukush mountains in north-western Himalayas, has been described by Wendelbo (1952). A comparison of the plants of Mt. Abu with the flora of Tirich Mir shows that only one species namely *Arenaria serpyllifolia* is common to the two places. The following twenty two genera found in Tirich Mir are also represented at Mt. Abu, but by entirely different species; not one species of these genera being common to the two areas:

Artemisia, *Berberis*, *Campanula*, *Carex*, *Cuscuta*, *Cynoglossum*, *Epilobium*, *Euphorbia*, *Geranium*, *Gnaphalium*, *Nepeta*, *Polygonum*, *Potentilla*, *Rosa*,

Salix, *Scirpus*, *Sedum*, *Senecio*, *Tricholepis*, *Verbascum*, *Veronica*, *Viola*.

Arenaria serpyllifolia occurs in Tirich Mir at 3600 m. Its general distribution is in Europe, Caucasus, Persia, South Asiatic USSR to Pamir Alai, Tienskan, West Siberia, Himalayas, Kashmir to Nepal and in North America. This species occurs widely in north India from 300 m to 3300 m altitude, and also in south in the Nilgiris. It is not reported by Santapau (1960) or Cooke (loc. cit.) from Bombay.

Comparison with Jammu and Kashmir

Kapoor, *et al.* (1951) have described economic plants of Sind Division of Kashmir. The altitude of the area of this work is generally about 3340 m. A comparison with the plants of Mt. Abu indicates that the following six species are common:

Angelica glauca, *Artemisia parviflora*, *Cynoglossum wallichii*, *Potentilla supina*, *Salix tetrasperma*, *Veronica beccabunga*. The occurrence of *Angelica glauca*, and *Veronica beccabunga* in Mt. Abu is of interest as these plants are not reported from hill stations in Bihar, Madhya Pradesh or South India. *Cynoglossum wallichii* occurs widely in Himalayas, and in other hill stations of India, not in plains. *Artemisia parviflora*, *Potentilla supina*, and *Salix tetrasperma* are plants of wide distribution.

Comparison with Siwaliks

There is no flora of the Siwalik region but the commoner plants, particularly trees, shrubs and climbers, have been referred by Puri (1950, 1960) in his account of the forest ecology of this area. Some plants from Siwaliks have been referred by Puri and Gupta (1961) in their Flora of Mussoorie.

140 species are common between Mt. Abu and the Siwaliks. Most of these are plants of wide general distribution. Following plants are among those which are restricted to northern India only and their southern limits are in Mt. Abu. They are common to Mt. Abu and Siwaliks, namely, *Aerides multiflorum*, *Berberis asiatica*, *Ficus palmata*, *Ranunculus sceleratus*.

Most of the region of Siwaliks is under biotic pressure and its vegetation is much disturbed. Tropical plants, typical of plain or low altitudes of India, grow there. Plants of waste places and weeds have also gained ground there and true Himalayan plants are but few now. Plants, which occur commonly in Siwaliks and are absent or scarce in inner range, include *Adina cordifolia*, *Boswellia*

serrata, *Casearia elliptica*, *Celastrus paniculata*, *Garuga pinnata*, *Nyctanthes arbor-tristis*.

Comparison with Himalayas in relation to other hills

188 species of Mt. Abu flora are common with Outer Himalayas, 234 with Middle Himalayas and only 52 species are common with Inner Himalayas.

Plants found in Outer, and Middle Himalayas and even Inner Himalayas include a large number of plants of general wide distribution. Plants reaching upto Inner Himalayas include *Urena lobata*, *Oxalis corniculata*, *Bidens biternata*, *Xanthium strumarium*, *Vernonia cinerea*, *Solanum surattense*, *S. indicum*, etc. These are plants mostly of waste places and roadsides and travel with human and animal traffic. Such plants reaching upto Outer and Middle Himalayas would number over a hundred. The Mountain Element common between the Himalayas and Mt. Abu can be classified in two groups—the General Mountain Element and Northern Mountain Element.

(a) The General Mountain Element includes plants which occur in all, or most of the mountainous regions of India. They do not occur in the plains. They have been found in the region of Himalayas, Mt. Abu, Parasnath, Pachmarhi and Ghats and hills of Deccan, or in most of these regions.

Such plants are *Arthraxon lancifolius*, *Barleria dichotoma*, *Capsella bursa-pastoris*, *Cardamine tri-chocarpa*, *Conyza stricta*, *Cynoglossum wallichii*, *Datura stramonium*, *Eragrostis nigra*, *Galinsoga parviflora*, *Gnaphalium hypoleucum*, *Geranium ocellatum*, *Indigofera pulchella*, *Lespedeza cuneata*, *Linum mysorense*, *Lindernia sessiliflora*, *Moghania bracteata*, *M. strobilifera*, *Nicandra physaloides*, *Pogostemon parviflorus*, *Plectranthus mollis*, *Reinwardtia indica*, *Shuteria involucrata*, *Sterculia villosa*, *Vigna capensis*, *Viola patrini* and *Stenophyllus capillaris*.

(b) The Northern Mountain Element includes those plants which are found in northern India, particularly the Himalayas, and come southwards only upto Mt. Abu.

Such plants are *Aerides multiflorum*, *Ammania senegalensis*, *Angelica glauca*, *Berberis asiatica*, *Celastrus stylosa*, *Cuscuta europea*, *Erythrina arborescens*, *Epilobium hirsutum*, *Ficus palmata*, *Nymphaea alba*, *Plectranthus rugosus*, *Potentilla supina*, *Pueraria stracheyi*, *Ranunculus sceleratus*, *Rosa involucrata*, *R. multiflora*, *Salix acmophylla*, *Sedum asiaticum*, *Veronica beccabunga*. Majority of these

species go upto Outer and Middle Himalayas only. *Ammania senegalensis*, *Arthraxon lancifolius*, *Sedum asiaticum* and *Sterculia villosa* are among those species which reach only to the Outer Himalayas.

Aerides multiflorum, *Barleria dichotoma*, *Berberis asiatica*, *Geranium ocellatum*, *Indigofera pulchella*, *Linum mysorense*, *Moghania bracteata*, *M. strobilifera* and *Shuteria involucrata* are among those species which reach to the Middle Himalayas.

Capsella bursa-pastoris, *Cardamine trichocarpa*, *Conyza stricta*, *Cuscuta europea*, *Cynoglossum wallichii*, *Eragrostis nigra*, *Ficus palmata*, *Galinsoga parviflora*, *Gnaphalium hypoleucum*, *Lespedeza cuneata*, *Nicandra physaloides*, *Nymphaea alba*, *Plectranthus rugosus*, *Stenophyllus capillaris*, *Vigna capensis*, and *Viola patrini* reach upto the Inner Himalayas.

Absence of those species which are reported from Middle and Inner Himalayan region from the Outer Himalayan region is probably due to their local absence from the regions taken for comparison, (namely Nainital and Mussoorie) or lack of our knowledge of these floras, than to any marked altitudinal difference. Some species like *Erythrina arborescens*, and *Pueraria stracheyi* may occur only in middle and inner ranges.

The above comparison of flora of Mt. Abu with that of other regions of India can be summarised as:

(1) The flora of Mount Abu contains Mountain Element belonging chiefly to subtropical and temperate region of India. This element can be classed in three groups: (a) Plants which occur in all or most of the mountain regions of India, i.e., in the Himalayas, Parasnath, Pachmarhi Hills, Western Ghats and other hills of southern India. This category is represented by 26 species; (b) Plants which are found only in Himalayas or moist places in northern India and whose southern limit of distribution in India is Mt. Abu. This category is represented by 19 species; (c) More interesting from phytogeographic view point is the Peninsular Element. This includes plants found in Ghats and hills of Deccan Peninsula and at Mt. Abu. Their northern limit of distribution in India is Mt. Abu. This category is represented by 38 species.

(2) There are only a few plants of alpine regions.

(3) A large number of plants are of wide general distribution. They are either weeds of cultivation, or plants of waste places and roadsides. They do not have much phytogeographic significance but

prove biotic influences on the vegetation.

(4) The biotic interferences are resulting in an invasion of xerophytic plants.

RELATIONSHIP WITH FLORA OF OTHER LANDS

Croizat (1952) discussed the distribution and possible tracks of dispersal of a number of families and genera of plants. His discussion vis-a-vis actual occurrence of some plants in Mt. Abu was examined.

Discussing the genus *Cardamine* he wrote about its occurrence—'*C. hirsuta*—Mountains of east Africa (Kilimanjaro to Ethiopia) and west Africa (Cameron), Mexico, Jamaica, Santo Domingo, West Australia'.

This (supported by numerous such instances) would suggest that Africa and south America once formed a single continental mass and these plants spread from a place in south of our maps long before the modern continents took on their current shapes.

The occurrence of *Cardamine hirsuta* (= *C. trichocarpa*) in India is not indicated by Croizat. The species occurs in India in the Himalayas, Mt. Abu and in hills of Deccan Peninsula. Its occurrence in India, such far apart from the regions indicated by Croizat, is accountable by accepting the theory of joint continental land mass as supported by Croizat.

Reinwardtia indica is found on mountains of northern, central, western and southern India. It is one of those plants which occur in India and then in the widely distant region of Martinica and Guadeloupe in Caribbean Sea between North and South America. Croizat (loc. cit.) suggested the path of dispersal of this genus from French West Indies through Canary Isles near Mediterranean, and Socotra Islands in the Arabian Sea to India. In India, this plant occurs in mountains and in moist regions. Mt. Abu, situated in west of the country, might have played significant role in distribution of this plant in India. The Indian mountain habitat seems to have suited its demands as Collett (1902) found several forms of this species in the Simla hills. A study of the genus as a whole in India should yield interesting data on its tendency of speciation in India.

Cuscuta—Two species of this genus are found in Mt. Abu. *Cuscuta reflexa* is widely distributed in India. *Cuscuta europea* is reported in India, so far, only from Mt. Abu and temperate Himalayas. It is not reported from south Indian hills. This con-

forms with the path of dispersal of *Cuscuta* according to Croizat who suggested three tracks starting from the eastern end of present South Africa; *one track streaming in the direction of the line of Afghanistan*. This channel bifurcates into two routes, the cold area plants moving on to the central Asia, and the monsoon flora moving towards Burma, etc.

Cuscuta europea, a temperate species, might have followed the former route and continued to Mt. Abu and then Himalayas, the rest of the species of *Cuscuta* followed the second route and spread to the whole continent.

COMPOSITION OF FLORA AND FEATURES OF DISTRIBUTION

Good (1953) broadly classified families, genera and species into various categories according to their distribution in world climatic types such as Tropical, Temperate, Cosmopolitan, Discontinuous, Endemic, etc. An analysis of the flora of Mt. Abu leads to following observations: (numbers in brackets denote species occurring in Mt. Abu):

Cosmopolitan and Subcosmopolitan families

Papilionaceae (45), Cyperaceae (24), Boraginaceae (6), Liliaceae (2), Naiadaceae (2), Oxalidaceae (1), Ceratophyllaceae (1), Crassulaceae (1), Compositae (30), Labiatae (14), Orchidaceae (4), Plumbaginaceae (2), Chenopodiaceae (1), Hydrocharitaceae (1), Nymphaeaceae (1), Gramineae (28), Scrophulariaceae (14), Gentianaceae (3), Caryophyllaceae (2), Geraniaceae (1), Lemnaceae (1) and Portulacaceae (1).

Predominantly Temperate families but extending wide

Oleaceae (7), Rosaceae (4), Salicaceae (2), Fumariaceae (1), Ranunculaceae (1), Cruciferae (4), Polygonaceae (4), Campanulaceae (1), Berberidaceae (1), Umbelliferae (4), Onagraceae (2), Primulaceae (1) and Papaveraceae (1).

Chiefly Tropical though extending to temperate regions

Acanthaceae (23), Malvaceae (10), Tiliaceae (9), Convolvulaceae (13), Solanaceae (10), Caesalpiniaceae (9), Euphorbiaceae (12), Mimosaceae (10), Urticaceae (8), Amaranthaceae (8), Lythraceae (6), Sterculiaceae (6), Commelinaceae (5), Vitaceae (4), Loranthaceae (3), Menispermaceae (2), Dioscoreaceae (2), Araceae (2), Annonaceae (1), Malpighiaceae (1), Bombacaceae (1), Pandanaceae (1), Zingiberaceae (1), Rutaceae (1), Ficoideae (1), Rubiaceae (8), Apocynaceae (6), Combretaceae (6), Rhamnaceae (4), Anacardiaceae (4), Nyctaginaceae (3), Sapindaceae (2), Tamaricaceae (2), Linaceae (2)*, Ebenaceae (1), Myrtaceae (1),

Samydaceae (1), Martiniaceae (1), Amaryllidaceae (1), Moringaceae (1), Salvadoraceae (1), Asclepiadaceae (7), Capparidaceae (6), Verbenaceae (5), Cucurbitaceae (4), Celastraceae (3), Ulmaceae (2), Meliaceae (2), Burseraceae (2), Polygalaceae (2)*, Palmae (1), Bixaceae (1), Eriocaulaceae (1), Pedaliaceae (1), Balsaminaceae (1), Begoniaceae (1) and Violaceae (1)*.

*Good places Linaceae, Violaceae and Polygalaceae in the Tropical families, but mentions that the genera *Linum*, *Viola* and *Polygala* are chiefly Temperate. These three families are represented in Mt. Abu, chiefly by these three genera.

The above analysis shows that the plant families considered by Good as primarily Tropical in distribution account for about 62 percent, and Temperate families only for 14 percent, of the total number of families occurring in Mt. Abu. Cosmopolitan families are about 24 percent. Species belonging to these families do not necessarily conform to the same geographical limits, as is the case of *Viola*, *Linum* and *Polygala* cited above. However, it is not insignificant that the total number of species in the families classified above comes to: Cosmopolitan, 185 or 41 percent; Temperate, 33 or 7 percent and Tropical 233 or 52 percent, which shows the dominance of Tropical and Cosmopolitan species.

Good also discussed genera of phanerogams on the basis of their general distribution, and classified into six groups—Cosmopolitan and Subcosmopolitan, Tropical, Temperate, other wides, Discontinuous and Endemic. All the genera of Mt. Abu flora are not discussed by Good but out of about 100 genera discussed by him more than 50 percent are classed as Tropical, 30 percent Cosmopolitan and only 20 percent Temperate. This is a very general inference, as within genera there are large variations for species and the following paragraphs, with species as the basis, give more precise indications.

The world distribution of plant species is described in a general way in floras (such as Hooker) and books on phytogeography (Croizat, Good). Index Kewensis briefly gives the main regions of distribution. An analysis of Abu flora has been attempted on the basis of these various sources. It is not always possible to assign a species precisely to one group or the other; several species are widely distributed, or sometimes widely separated. It is, however, possible to infer the dominance of certain elements over others; this is of significance in a study of phytogeographical relationships. It will be seen

that the flora of Mt. Abu consists of a number of different regional elements.

The Indian Element is dominant, next comes the General Tropical Element. Other important Elements constituting the flora are the Malayan, African and Australian. Some Tropical American, Mediterranean and European plants are also present, they are chiefly weeds, mostly of recent entry.

The Indian and General Tropical Elements constitute about 50 percent of the flora.

The remaining 50 percent species are grouped as following:

Himalayan Plants in Flora of Mt. Abu (17 species)

Angelica glauca, *Berberis asiatica*, *Celastrus stylosa*, *Erythrina arborescens*, *Geranium ocellatum*, *Indigofera pulchella*, *Ipomea muricata*, *Isachne dispar*, *Jasminum grandiflorum*, *Lespedeza cuneata*, *Lindernia sessiliflora*, *Mitragyna parvifolia*, *Plectranthus rugosus*, *Pueraria tuberosa*, *Sedum asiaticum*, *Verbascum chinense*, *Viola patrinii* (it extends to Russia and north Asia).

Eastern and south-eastern Asia (56 species)

Plants showing Malayan affinities in the flora (36 species):

Aglaia odoratissima, *Anisomeles indica*, *Anthocephalus cadamba*, *Asteracantha longifolia*, *Azanza lampas*, *Bauhinia racemosa*, *Capparis sepiaria*, *C. zeylanica*, *Carissa congesta*, *C. opaca*, *Celastrus paniculata*, *Commelina obliqua*, *Cyanotis cristata*, *Cynoglossum wallichii*, *Dendrophthoe falcata*, *Erythrina subumbrans*, *Euphorbia nerifolia*, *Ficus lucescens*, *F. retusa*, *Flacourtia indica*, *Garuga pinnata*, *Girardinia zeylanica*, *Gmelina arborea*, *Limnophila indica*, *Mangifera indica*, *Marsdenia tenacissima*, *Michelia champaca*, *Moghania strobilifera*, *Porana paniculata*, *Rorippa indica*, *Salix tetrasperma*, *Salmalia malabarica*, *Smithia conferta*, *Terminalia bellirica*, *Toona ciliata* and *Zizyphus mauritiana*.

Plants showing affinities with Burmese flora (14 species):

Artemisia parviflora, *Barleria dichotoma*, *Buchanania lanzan*, *Butea monosperma*, *Capparis grandis*, *Ficus glomerata*, *Hiptage benghalensis*, *Kydia calycina*, *Lannea coromandelica*, *Pogostemon heyneanum*, *Remusatia vivipara*, *Tamarix dioica*, *Vicoa indica* and *Zizyphus rugosa*.

Plants showing affinities with Chinese flora (6 species):

Jasminum officinale, *Nymphoides cristatum*, *Po-*

gostemon parviflorus, *Rosa involucrata*, *Smithia salsuginea* and *Spermadictyon suaveolens*.

(Good mentions *Jasminum officinale* as, also Western and Central Asian).

Plants showing affinities with Australian flora (24 species)

Apluda mutica, *Boerhavia chinensis*, *Casearia elliptica*, *Cayratia carnosa*, *Cordia dichotoma*, *Crotalaria medicaginea*, *Cyperus exaltatus*, *Desmodium gangeticum*, *Dopatrium junceum*, *Ehretia laevis*, *Grewia rhamnifolia*, *Helicteres isora*, *Abelmoschus ficulneus*, *Ipomea obscura*, *Mallotus philippensis*, *Mimulus strictus*, *Pongamia pinnata*, *Pouzolzia zeylanica*, *Salvia plebeia*, *Semecarpus anacardium*, *Syzygium cumini*, *Trichosanthes cucumerrina*, and *Viscum articulatum*.

Africa and Arabia (46 species)

Plants showing affinities with African flora (34 species):

Acacia nilotica, *A. pennata*, *Aerva persica*, *A. sanguinolenta*, *Albizia lebbeck*, *Arthraxon lancifolius*, *Barleria prionitis*, *Buchnera hispida*, *Calotropis procera*, *Cocculus hirsutus*, *Conyza stricta*, *Cyperus paniceus*, *Desmostachya bipinnata*, *Emilia sonchifolia*, *Eriocaulon cinereum*, *Ficus benghalensis*, *F. palmata*, *Grewia flavescens*, *G. tenax*, *G. tiliaefolia*, *G. villosa*, *Justicia simplex*, *Kirganelia reticulata*, *Lantana trifolia*, *Lindernia parviflora*, *Pedaliium murex*, *Peristrophe bicalyculata*, *Phaseolus radiatus*, *Polygala erioptera*, *Pupalia lappacea*, *Sclerocarpus africanum*, *Striga gesnerioides*, *Triumfetta pilosa* and *Woodfordia fruticosa*.

Plants common with Arabia, Persia or Abyssinia (12 species):

Arundinella pumila, *Chlorophytum tuberosum*, *Dipteracanthus patulus*, *Dyerophyton indicum*, *Ehretia aspera*, *Leucas urticaefolia*, *Nerium indicum*, *Pandanus tectorius*, *Prosopis spicigera*, *Salvadora persica*, *Trichodesma indica* and *Zizyphus nummularia*.

Temperate regions

Plants of general temperate and subtropical regions (17 species):

Capsella bursa-pastoris, *Cardamine trichocarpa*, *Centella asiatica*, *Ceratophyllum demersum*, *Chenopodium ambrosioides*, *Convolvulus arvensis*, *Fumaria indica*, *Nymphaea alba*, *Oxalis corniculata*, *Polygonum plebeium*, *Potamogeton crispus*, *P. pectinatus*, *Potentilla supina*, *Ranunculus sceleratus*, *Spirodela polyrhiza*, *Veronica anagallis*, *V. beccabunga*.

Plants showing affinities with European, or Mediterranean flora (11 species):

Anagallis arvensis, *Arenaria serpyllifolia*, *Cuscuta europea*, *Epilobium hirsutum*, *Fimbristylis bisumbellata*, *Melilotus indica*, *Nepeta hindostana*, *Setaria glauca*, *Sonchus arvensis*, *Vicia hirsuta* and *V. sativa*.

Plants showing affinities with the tropics of America (Brazil, Mexico, etc.) and West Indies (22 species):

Acanthospermum hispidum, *Argemone mexicana*, *Asclepias curassavica*, *Bidens biternata*, *Eranthemum roseum*, *Furcraea gigantea*, *Galinsoga parviflora*, *Helianthus annuus*, *Lagascea mollis*, *Lantana camara*, *Martinia annua*, *Mirabilis jalapa*, *Nicandra physaloides*, *Nicotiana plumbaginifolia*, *Oenothera rosea*, *Pithecellobium dulce*, *Rotala mexicana*, *Sida acuta*, *S. veronicaefolia*, *Solanum seaforthianum*, *Tithonia tagetifolia* and *Tridax procumbens*.

Some of the plants in above list are now widely spread in whole of India, e.g. *Tridax procumbens*, *Bidens biternata*, *Lantana camara*, *Sida acuta*, *Asclepias curassavica*, *Acanthospermum hispidum*, *Martinia annua* and *Argemone mexicana*. Many have spread in Mt. Abu, of recent and are still of localised distribution in India, e.g. *Solanum seaforthianum*, *Tithonia tagetifolia*, *Rotala mexicana*, *Galinsoga parviflora*, *Helianthus annuus*.

The above analysis of the plants occurring at Mt. Abu, vis-a-vis their world distribution can be summarised as below:

Indian Element	...	...	...	147
General	...	...	...	130
Temperate Himalayan	...	...	...	17
Tropical Plants	...	...	...	120
Species occurring in Tropics of Asia	...	...	...	19
Species occurring in Old World Tropics	...	...	...	46
Species occurring in All Tropical regions	...	...	...	55
Cosmopolitan species	...	...	...	9
Eastern, South-eastern Asian and Australian	...	...	...	80
Species occurring in India and China	...	...	...	6
Species occurring in India and Burma	...	...	...	14
Species occurring in India and Malaya	...	...	...	36
Species occurring in Australia	...	...	...	24
African-Arabian	...	...	...	46
Africa	...	...	...	34
Arabia	...	...	...	12
Temperate and Subtropical plants	...	...	...	28
General Temperate regions	...	...	...	17
Europe and Mediterranean	...	...	...	11
American	...	...	...	22

CONCLUSION

A comparison of the flora of Mt. Abu with that of other regions in India and an analysis of the constituent species in relation to their general world distribution patterns, e.g. Tropical, Temperate, Cos-

mopolitan, Discontinuous, etc., leads to the following observations:

The Temperate or Himalayan plants constitute only about 4 percent of the total flora of Mt. Abu, and about 13 percent of the Indian Element in that flora.

More than 25 percent of its species are of wide distribution in tropics of Asia or general tropics of the world.

Next in dominance are the south-east Asian or Malayan and Australian plants. 80 species are common with these areas. These species are generally widely spread in India.

24 species are common with Australian flora.

The African-Arabian Element, which is chiefly xerophytic, is represented by 46 species. Some of these species, such as *Prosopis spicigera*, *Zizyphus nummularia*, *Trichodesma indica*, *Aerva* sp., *Calotropis procera* and *Grewia tenax*, form the chief types in the Indian desert, and species of *Aerva* and *Zizyphus* colonise the poorest habitats in Rajasthan. They must have invaded Mt. Abu due to biotic interference, such as lopping, felling and burning of forests. Most of these 46 species occur in India in drier regions, and ascend on hills in Himalayas or in south India, chiefly, under biotic interference. Some of these, such as *Sclerocarpus africanus*, *Pedaliium murex* and *Leucas urticaefolia*, grow commonly as agricultural weeds.

28 species are common with temperate and sub-tropical regions of Europe and other countries. Many of these occur at Mt. Abu due to its higher altitude. They grow in the Himalayas too. These, and the 17 temperate Himalayan species, form the Temperate or Mountainous Element of Mt. Abu flora. Their frequency is low compared with the tropical region plants. Most of these are plants of aquatic and marshy situations. A few are purely agricultural weeds, such as *Anagallis arvensis*, *Melilotus indica*, *Chenopodium ambrosioides*, *Capsella bursapastoris* and *Fumaria indica*.

22 species are common with American flora. Almost all of these are agricultural weeds or plants which have run as escapes from cultivation. Consequently, they are more frequent near habitations, rather than inside the forests.

The following is an analysis of the recent new records from Mt. Abu (Jain, 1962).

Cosmopolitan or Tropical species 24, Indian 12, African-Persian 9, American 8, Temperate and European 6, Australian 3 and Malayan 2.

70 percent of these new records comprise Cosmopolitan, Indian or African Elements, whereas less than 10 percent comprise Temperate or European plants.

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