SOME OBSERVATIONS ON PLANTS OF THE SOUTH INDIAN HILLTOPS AND THEIR DISTRIBUTION *

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It is a well-known fact that hilltops in the tropics possess a characteristic flora of their own. Generally there is a change in the aspect of the vegetation at about 3,000 feet (1,000 metres) altitude, as shown by Trimen (1886) for Ceylon, Meebold (1909) for Bababudangiris in Mysore, Stamp (1925) for Burma, Ward (1927) for Sino-Himalayas, and Steenis (1934–36) for Malaysia.

Chatterjee (1940) while studying the endemic flora of India and Burma observes that in the hilly or mountainous regions—in the Himalayas, Khasias, Burma hills and Nilgiris, altitude is the dominating factor in determining the nature of vegetation. It may be remarked that although these regions are widely separated, the vegetation of the upper subtemperate regions is similar in all. In all cases the lower zone is characterized by evergreen forests, and the higher altitudes tend to have subtemperate forests as evidenced by the larger number of species adapted to life in cooler climates. Thus there is a transition from the evergreen to the subtemperate species as one ascends the hills. This transition has been shown by Steenis (1934–36) to occur at 1,000 m., and has been observed by the present author in the vegetation of Nandidroog, Bababudangiris and Biligirirangans of Mysore State, the Pulneys and Nilgiris in Madras State, and the hills in Poona District (like Simhagad and Torna) of Bombay State. Here the plants are exposed for the greater part of the year to cool climates and the diurnal range of temperature is not great. Whereas in the evergreen forests at the base of these hills humidity is the master factor, in the higher altitudes temperature is important.

In the present study an attempt has been made to find out the status of the subtemperate species of the South Indian hilltops, and, from their distribution, determine the origin or origins of this flora. With this end in view, a list of all plants reported from above 3,500′ in the South Indian hilltops of Madras and Mysore States has been prepared from available literature, and their present distribution checked by reference to all floras of the adjacent regions.

For an analysis of the distribution of hilltop plants it becomes necessary to consider the botanical provinces of India. Pioneer work on dividing India into such provinces was done by Hooker and Thomson (1855); and later workers on the same include Clarke (1898), Prain (1903–08), Hooker (1909), Calder (1938) and Chatterjee (1940). Among these, Hooker and Thomson's divisions, which are based on physiographic and climatic factors as affecting growth and distribution of vegetation are the only ones which can be utilized for a detailed analysis of distribution of plants within India. The others' divisions are far too generalized to be of any use for this purpose. Hence, the provinces of Hooker and Thomson (1855, pp. 118–245) are utilized for the present study. The approximate outlines of these provinces are shown on the accompanying map, the provinces being serially

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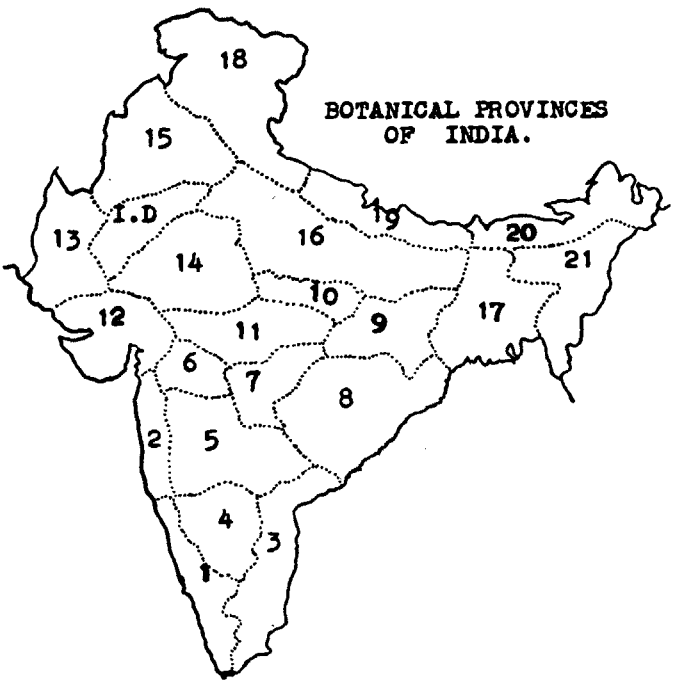
numbered for easy reference. In this account, 'India' is understood to mean the whole of the sub-continent excluding Burma. The only deviation from Hooker and Thomson is that their East India has been replaced by North-east India and includes Assam, Cachar, Silhet, Chittagong, Tippera, Mishmee, Naga and Khasia hills. The other provinces are as defined by Hooker and Thomson (*l.c.*).



These provinces are: (1) Malabar (Ceylon is included here for the sake of the present study); (2) Concan; (3) Carnatic; (4) Mysore; (5) Deccan; (6) Khandesh; (7) Berar; (8) Orissa; (9) Bihar; (10) Bandelkhand; (11) Malwa; (12) Gujerat; (13) Sind; (14) Rajwara; (15) Punjab; (16) Upper Gangetic Plain; (17) Bengal; (18) North-west Himalayas; (19) Central Himalayas; (20) Eastern Himalayas; (21) North-east India; and I.D. = Indian Desert.

In the list referred to above, all species reported to occur above 3,500′ altitude in the hills of Madras State and Mysore have been included. Thus, there is a large number of species which have their nearly related species occurring at lower altitudes in these hills, or themselves occur at lower altitudes elsewhere. The last category has been omitted. In analyzing the distribution of the hilltop plants the following points have been kept in view:—

(i) The total surface on which mountain genera can settle is extremely small, the area below 3,500′ being cut off. Hence, this mountain flora can be compared to an island flora for all practical purposes, or, as Steenis (1934–36) says these hill-tops can be compared to islands of subtemperate vegetation in a sea of tropical vegetation found at the base of these mountains.

(ii) The mountain flora is a more favourable subject for study than the true tropical flora of the lowlands, because the temperate elements of the mountain flora represent an offshoot from the centres of development of temperate genera.

(iii) Such a mountain flora has two types of plants: (*a*) representatives of genera which are common to and centre in temperate regions; (*b*) representatives of a true tropic stock which have produced temperate species.

(iv) By limiting our consideration to category (*a*) the number of possible explanations is reduced; while category (*b*) does not furnish critical evidence for former migrations, as it is understood that their representatives have originated where they are found at present.

(v) Proof of actual migration must be given. Since proof from fossils is not available to us, we have to search for it in the present distributional facts by considering the distribution of all the species of a genus, and by comparing their specific areas with one another.

(vi) Perhaps a less critical proof would be to compare distribution patterns of groups of species.

Taking methods envisaged in (v) and (vi) together, the question revolves itself in finding the distribution patterns of present day plants and their bearing on ancient dispersals.

(vii) That dispersal and migration of plants take place cannot be denied, since all plants extend their areas. Now, for each genus there seems to be a centre or centres of development. From the centre of development to the border, the number of species decreases. The number of species on the borders of genera will naturally show the direction of migration from the centre to the periphery, though not in all cases.

Distribution Patterns

In accordance with the occurrence of hilltop species in various provinces as shown on the Map there are a few fundamental distribution patterns discernible. The following are the main patterns and their variations as exhibited by the 1,224 species so far reported from hills in Madras and Mysore States.

A. There are 857 species in Province *1*, and a further 97 in Province *2*. Thus there are 954 species restricted to the Western Ghats and extending to Ceylon. All these can be taken to be endemics and as such of not much value in giving us any direct clues as to the origins or routes of migrations. It should not, however, be forgotten that such endemics could be utilized for the purpose indicated.

B. **Species that occur in Provinces *1*, *2*, *3*** form one basic pattern. Here it should be remembered that their occurrence has been reported from the northern part of Province *3*. This pattern obviously shows an intermigration of species between the Eastern and the Western Ghats. Alternatively, these species could have reached the Eastern and Western Provinces from some common source. Such species include:

Dysophylla myosuroides Benth.,
Elaeagnus kologa Schlecht.,
Eulophia ochreata Lindl.,
Ipomaea wightii Choisy.,
Microstylis versicolor Lindl.,
Smithia hirsuta Dalz.,
Solanum denticulatum Bl.,
Viburnum acuminatum Wall.,
Wendlandia notoniana Wall.

Atylosia sericea is similar but does not occur in Province *1*.

Species that occur in Provinces *1* and *3* include:

Adenostemma reticulatum DC.,
Amphilophis insculpta Stapf.,
Anaphalis lawii Gamble.,
Blumea hieracifolia DC., var. *macrostachya* Hook f.,
Bupleurum mucronatum W. & A.,
Carex myosurus Nees.,
Celosia pulchella Moq.,
Cinnamomum wightii Meissn.,
Decalepis hamiltonii W. & A.,

Eriocaulon conicum (Fyson), Fischer = *E. dianae* Fyson., var. *conica* Fyson.
Eulalia phaeothryx O. Ktz. (Tonkin),
Exacum perottetii Griseb.,
Habenaria longicornu Lindl.,
Knoxia heyneana DC.,
Ligustrum roxburghii Clarke.,
Lonicera leschenaultii Wall.,
Ophiorrhiza hispidula Wt.,
Osbeckia hispidissima Wt.,
Pavetta breviflora DC.,
Rungia parviflora Nees., var. *monticola* Gamble.,
Strobilanthes cuspidatus T. And.

Species in Provinces *1, 2, 3, 8* and *9* are:

Exacum bicolor Roxb.,
Solanum giganteum Roxb.,
Sopubia trifida Buch. Ham.

Species in Provinces *1, 2, 8* and *9* include:

Euphorbia pycnostegia Boiss.,
E. zornioides Boiss.,
Habenaria digitaria Lindl., var. *foliosa* Hook f.

Species in Provinces *1, 2, 10* and *11*:

Senecio edgeworthii Hook f.

Species in Provinces *1, 2* and *9* include:

Eriocaulon conicum Hook f.,
Fimbristylis nigrobrunnea Thw. (Nicobars, Cambodia),
Justicia orbiculata Wall. (Siam),
Oxytenanthera nigrociliata Munro.,
Pilea trinervia Wt.,
Gymnema hirsutum W. & A.,
Sideroxylon tomentosum Roxb.

Species in Provinces *3, 8* and *9* include:

Brachiaria kurzii A. Camus.,
Hypserpe cuspidata Miers.,
Lasianthus tomentosus Bedd.,
Lasiococca comberi Haines.,
Pygeum andersonii Hook f.

Species in Province *3* only:

Osbeckia reclava D. Don., var. *pulchella* Triana.,
Memecylon madgolense Gamble.,
Senecio candicans DC.,
Tephrosia roxburghiana J. R. Drumm.

Carissa paucinerva A. DC., occurs in Provinces *1, 3, 8* and *9*.

From a perusal of the above distributions it is seen that there is a disjunction between the western and the eastern provinces. All the same one can discern a south-west to north-east trend in these disjunctions. This becomes more evident in the following distribution patterns.

C. **Species that occur in Provinces *1, 2, 3, 8, 9, 18–21*:**

Laggera alata Sch. Bip. (China, Burma, Malaya, Philippines, tropical Africa),
Rubus ellipticus Sm. (China, Burma).

Species in Provinces *1, 3, 8, 9, 18–21*:

Artemisia parviflora Buch. Ham.,
Campanula canescens Wall. (Pegu),
Conyza japonica Less. (China, Burma, Afghanistan),
Exacum tetragonum Roxb. (China),
Hydrocotyle rotundifolia Roxb. (Malaya),
Laggera pterodonta Roxb. (Burma, tropical Africa),
Micromeria biflora Benth.,
M. capitellata Benth.,
Pittosporum floribundum W. & A.,
Polygonum chinense Linn. (Burma, China, Malaya, Japan),
Rhamnus nepalensis Lows.,
Symplocos spicata Roxb. (China, Japan, Martaban),
Thalictrum javanicum Bl.,
Viola patrinii DC. (Afghanistan, W. Tibet, N. Asia, Japan),
Youngia japonica (L.) DC., var. *genuina* (Hochr) Babcock and Stebbins (China, Afghanistan, Japan, Malaya, Mauritius).

Arisaema tortuosum Schott., occurs in Provinces ***1, 2, 3, 8, 9, 20, 21.***

Species in Provinces *1, 2, 3, 8, 9, 10, 18–21*: *Plectranthus coesta* Buch. Ham., (Burma, Afghanistan).

Species in Provinces *1, 3, 8–11, 18–21*: *Launaea acaulis* (Hook f) Babcock.

Species in *1, 2, 8–11, 18–21*: *Habenaria commelinifolia* Linn.

Species in *1, 8–11, 18–21*: *Limnophila hypericifolia* Benth.

Species in *1, 2, 3, 18–21*: *Rubus gardnerianus* O. Ktz. (Burma, Malay Archipelago); *R. niveus* Thunb. (Burma, Java).

Species in Provinces *1, 3, 18–21*: *Galium asperifolium* Wall. (Burma, Ava, Martaban); *Eulalia quadrivalvis* O. Ktz., var. *wightii* Hook f., *Fragaria indica* Andr. (Afghanistan, China, Japan, Korea, Penang, Malaya).

Species in Provinces *1, 2, 8, 9, 18–21*: *Dumasia villosa* DC. (Java, Madagascar, Natal); *Hydrocotyle javanica* Thunb. (Pegu, Tenasserim, Malaya, Philippines, Madagascar).

Species in *1, 8, 9, 18–21*:

Blumea hieracifolia DC. (Java),
Calamintha umbrosa Benth. (Afghanistan, Caucasia, China, Japan, Java),
Conyza viscidula Wall. (Burma, Java, New Caledonia, Philippines, Australia, Africa),
Desmodium parviflorum DC. (Burma, China, Japan, Malaya),
Lipocarpha argentea R. Br. (tropics and subtropics of the Old World),
Microstegium ciliatum A. Camus.,
Phoebe lanceolata Nees.,
Polygonum minus Huds. (Europe, tropical and temperate Asia),
Potentilla kleiniana W. & A.

Species in *1, 8, 9, 18*: *Conyza aegyptiaca* Willd. (Africa, China, Japan Australia).

Pattern *D* shows the following groups:—

Species in Provinces *1, 2, 3, 20-21*:

Impatiens chinensis Linn.,
Luisia teretifolia Lindl. (Malaya to New Caledonia),
Neolitsea zeylanica Merr. (Burma, Malaya, Penang),
Olea glandulifera Wall.,

Paramignya monophylla Linn.,
Phoebe paniculata Nees.,
Rauwolfia densiflora Benth. & Hook f.,
Tylophora macrantha Hook f.

Species in Provinces *1, 2, 8, 9, 18*: *Allophylus rheedii* Radlk.,
Plectranthus incanus Link.

Species in Provinces *1, 3, 18*: *Carex baccans* Nees.,
Clausena heptaphylla W. & A.,
Morinda umbellata Linn.

Species in Provinces *1, 8, 9, 18*: *Macaranga indica* Wt.,
Polygonum pedunculare Wall.

Pattern *E* consists of the following groups:—

Species in Provinces *1, 18–21* are:

Acalypha brachystachya Hornem.,
Agrostis pilosula Trin.,
Brachiaria semiundulata Stapf.,
Campanula ramulosa Wall.,
C. wightii Gamble.,
Chambainia cuspidata Wt.,
Cnicus wallichii Hook f.,
Cotoneaster buxifolia Wall.,
Elatostemma sessilis Forsst.,
Epipactis consimilis Wall.,
Geranium nepalense Sweet.,
Gnaphalium hypoleucum DC.,
Hypericum hookerianum W. & A.,
H. wightianum Wall.,
Jasminum bignoniaceum Wall.,
Laportea terminalis Wt.,
Luzula campestris DC.,
Mahonia leschenaultii Takeda.,
Microstegium nudum A. Cam.,
Microstylis wallichii Lindl.,
Parochaetus communis Hamilt.,
Peperomia heyneana Miq.,
Picris hieracioides Linn.,
Piper brachystachya Lindl.,
Pratia begonifolia Lindl.,
Rhamnus virgatus Roxb.,
Senecio intermedius Wt.,
S. wightiana DC.,
Spiranthes sinensis Ames.,
Thalictrum saniculaeforme DC.,
Torenia vagans Roxb.,
Vandellia nummularifolia Lindl.,
Viburnum coriaceum Bl.,
V. erubescens Wall.

Anotis wightiana Benth. & Hook f. (Ava, Cochinchina, Malaya),
Brunella vulgaris Linn. (temperate zones of northern hemisphere, Australia),
Gentiana pedicellata Wall. (China, Burma, Java),
Gymnostemma pedata Bl. (Japan, Malaya),
Polygala sibirica Linn. (Siberia, China, Japan),
Rumex nepalensis Spreng. (Java, westward to Asia and South Africa),
Sagina procumbens Linn. (Tibet, north and south temperate zones),
Sanicula europaea Linn. (Malaya, Europe, Asia, Africa).

Species in Provinces *1, 20-21* include:

Agrostis stolonifera Linn.,
Anemone rivularis Ham.,
Arthraxon rudis Hochst.,
Arundina graminifolia Hochr.,
Arundinaria fuscata Nees.,
Avenastrum asperum Fischer.,
Calamintha masuca Lindl.,
Campanula fulgens Wall.,
Carex filicina Nees.,
C. jackianus Boott.,
C. longicruris Nees.,
C. longipes D. Don., var. *dissitiflora* Cl.,
C. maculata Boott.,
Desmodium scalpe DC.,
Dianella ensifolia Red.,
Elatostemma acuminata Brongn.,
Epipogum nutans Reichb. f.,
Eriocaulon melaleucum Mart.,
Fragaria neelgherrensis Schlecht.,
Gardneria ovata Lindl.,

Gentiana quadrifaria Bl.,
Glochidion fagifolium Hook f.,
Justicia latespicata Gamb.,
Leucas zeylanica R. Br.,
Liparis pusilla Ridl.,
L. viridiflora Lindl.,
Lonicera ligustrum Wall.,
Lysimachia ovata Buch Ham.,
Mastixia arborea Clarke.,
Parnassia mysorensis Heyne.,
P. wightiana Wall.,
Pentapanax leschenaultii Seem.,
Phoebe wightii Meissn.,
Pilea wightii Wedd.,
Potentilla leschenaultiana Ser.,
Procris wightiana Wall.,
Rapanea wightiana Mez.,
Sageretia hamosa Brongn.,
Sicrpus fluitans Lindl.,
Scutellaria rivularis Benth.,
Senecio walkeri Arn.,
Smithia blanda Wall.,
Ternstroemia japonica Thunb.,
Tropidia angulosa Bl.,
Viola distans Wall.,
Youngia fuscipappa Thw.

Species in Provinces *1, 2, 18, 20-21*:

Eulophia herbacea Lindl.,
Parietaria debilis Forsst. (many temperate and tropical regions extending to Australia and Fiji),
Polygala persicariaefolia DC. (tropical Africa, Australia).

Species in Provinces *1, 2, 18*:

Arenaria neelgherrensis W. & A.,
Cheirostylis flabellata Wt.,
Digitaria ternata Walp.,
Meliosma arnottiana Walp.

Species in *1, 2, 19–21*: *Rubus fairholmianus* Gardn. (Borneo, Malaya).

Species in *1, 18, 20-21*: *Korthalsella japonica* Edgew.,
Scutellaria paniculata Edgew.

Species in Provinces *1, 19–21*:

Carex hebecarpa C. A. Mey., var. *ligulata* Kukenth. (China, Japan),
Gaultheria fragrantissima Wall. (Burma, Malaya),
Polygala arillata Buch Ham. (South China, Ava, Malayan Archipelago),
Stellaria saxatilis Ham. (Siberia, Japan, Java).

The following groups of species form Pattern *F*.

Species in *1, 2, 3, 10-11*: *Eriocaulon longicuspis* Hook f., var. *polycephala* Fyson.

Species in *1, 3, 10-11, 18–21*: *Ophiopogon intermedium* D. Don., *Sarcococca trinervia* Wt. (Afghanistan, Sumatra).

Species in *1, 2, 3, 14, 18–21*: *Lecanthus wightii* Wedd. (Java, Africa).

Species in *1, 2, 3, 8, 9, 18–21*: *Artemisia vulgaris* Linn. (Siam, Java, Africa, Australia).

Species in *1, 2, 14, 18–21*: *Vernonia conyzoides* Wt. (tropical Asia, Africa, Australia).

Species in *1, 2, 14, 18*: *Linum mysorense* Heyne.

Species in *1, 18*: *Ranunculus muricatus* Lindl. (Europe, West Asia, temperate North America).

Species in *1, 18, 19*: *Juncus glaucus* Ehrh. (Europe, N. Asia, N. Africa).

Species in *1, 14, 18, 20-21*: *Carex breviculmis* R. Br. (China, Japan, Australia, New Zealand).

The undermentioned groups of species constitute Pattern *G*.

Species in Provinces *3, 20-21*:

Disporum calcaratum D. Don.,
Emilia bambusifolia Lindl.,
E. scabra Don.,
Gymnosporia acuminata Hook f.,
Pericampylus incanus Miers.,
Strobilanthes theaefolia D. Don.,
Uncaria sessilifructus Roxb.

Species in Provinces *3, 8, 21*:

Anotis calycina Wall.,
Cinnamomum caudatum Nees.
Calamus latifolia Roxb., occurs in Provinces *3, 8, 9, 11, 18.*

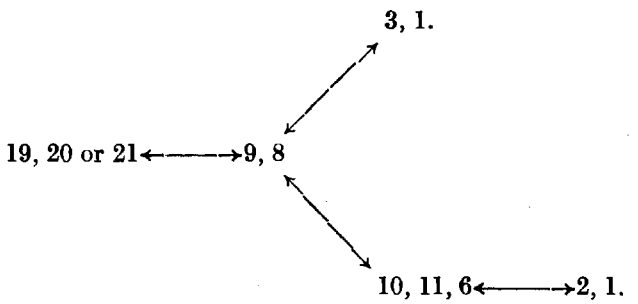
Species in Provinces *3, 8, 9, 18–21*:

Dendrobium bicameratum Lindl.,
Ehretia acuminata R. Br. (China, Japan, Burma, Malaya, N. Australia),
Senecio nudicaulis Buch Ham.

These distribution patterns indicate certain migratory tracts. It will be noticed that in most of the patterns there is a prevailing south to north-east trend, and in many of these the routes could have been:—

1←——→3 and/or 8, 9←——→20-21.

The distribution pattern *C* and its variants indicate the possibility of this route. The possibilities of migration are:—



It has already been remarked while enumerating pattern *B* that there could have been a possible intermigration of species between the mountains of the east and the west, or in the alternative these could have been derived from some common source. The common source could have been the provinces Bihar and Orissa.

Thus it appears that Provinces *8* and *9* have played an important rôle in the migration of plants from South-west to North-east India or vice versa. This fact confirms the belief of earlier workers like Hooker and Thomson (1855), and Fyson (1915–21, 1932). Hooker and Thomson (*l.c.*, p. 126) say that the ravines and the shady parts near the undulating slopes of the Nilgiris are occupied by thickets and small bushes like those of Ceylon, but probably composed of greater number of species all of which are equally characteristic of similar situations in the Khasias.

Fyson (1932) says that some 17% of the species occur on the Khasia hills, 1,500 miles away, and about 12% on the temperate parts of the Himalayas, but practically none at all in the intervening country, even along the Western Ghats.

These two authors have thus shown the similarity between the plants of South Indian hills and those of Himalayas; and the same has been hinted at by Chatterjee (1940). The sweeping statement made by Fyson that there are no common plants in the intervening countries does not receive support from the present study. In fact the recurrence of Provinces *3*, or *3*, *8* and *9* in most of the distribution patterns appears to be directly opposed to Fyson's views.

The present study has thus confirmed the similarities between the high altitude floras of the South Indian hills and the Himalayas, and has also suggested probable routes of migration between the two areas. The question still remains as to direction in which migration has taken place.

It should be remembered that the area with which we are concerned is one of the oldest known land masses of the earth, and as such it is reasonable to expect that it has been covered by some sort of vegetation from the early times. This assumption can naturally be extended to the belief that there was some vegetation in this area even before the advent of the Himalayas. This belief happens to be true as evidenced by the facts of the area forming part of the old Gondwana continent. As to the exact nature of the old vegetation there are no means of finding out at present, particularly so in the absence of fossil data.

The work of several persons indicates that the flowering plants originated on the southern land mass. Among these, we can notice the opinions of two eminent phytogeographers. Hill (1926, p. 1480) in his masterly essay on 'Antarctica and problems of plant distribution' remarks that '*Vernonia*, on the present day evidence appears to belong to the south, and from a primitive species, which probably reached South Africa, South America and India—from Antarctica, that modern species have originated'.

Camp (1946) while dealing with the distribution patterns in modern plants and the problems of their ancient dispersals adduces evidence which makes it abundantly clear that the southern land masses appear to be the possible areas of origin in so many groups of land plants. It seems likely that angiosperms as a group arose on the southern land mass contemporaneous with the palaeozoic of the northern (holarctic) land mass and that the divergence of the familial groups had been accomplished on this southern mass certainly by the mid-Mesozoic. Further, Camp is of the opinion that a great bulk of the angiosperm families and many of their present day genera appear to have evolved by the Cretaceous, and that this angiosperm group began moving northwards, so that by the Eocene at least sub-tropical genera became abundant on the lower parts of the northern land mass. These observations of Camp are directly opposed to the view generally held that the angiosperms, as all other plants, arose in the north and that there has been a southward migration. A good account of the latter view is given by Just (1947).

Whatever the case, or the merits and demerits of the two views, for the sake of the present study it can be assumed that migration has occurred both ways, for, as far as migrations of plants are concerned, there can be no one-way traffic. Among those plants that have come from a northern source can be mentioned species of *Hypericum*, *Parnassia*, *Thalictrum*, *Gordonia*, *Clematis*, *Rubus* and *Lonicera*; while among plants that have originated in the south can be mentioned *Procris*, *Heynea*, *Allophylus*, *Pygeum*, *Schefflera*, *Mastixia*, *Maesa*, *Isonandra*, *Symplocos*, *Cryptocarya*, *Cinnamomum*, *Litsea*, *Neolitsea*, *Phoebe*, *Daphniphyllum* (Malaysian), *Lobelia* and *Conyza* (African) as established by Razi (in press).

In this connection, the views of Mooney (1942) on the occurrence of South Indian plants on the Bailadila Range in Bastar State of Orissa are interesting. He says that it does not call for great powers of imagination to visualize how species having their origin in the Nilgiris, Pulneys and other hills of Mysore, Travancore

and Southern India may have travelled along the line of the Eastern Ghats until they reached their northern extremity in Kasipur Plateau of Kalahandi State, and the Agency tracts of Ganjam and Vizagapatam districts with their humid coastal climate and many hills exceeding 4,000′ in altitude. The distance from the southern plateau of Kalahandi to Bailadila in a straight line is not more than 120 miles; but Tulsi Dangi, itself 3,914′ situated about 150 miles east of Bailadila and other intermediate hill ranges of lesser calibre shorten the gap. Mooney, thus presents clear evidence of the south to north migration in the occurrence of 32 species of South Indian plants in the Bailadila range. On the other hand, he found it difficult to explain the occurrence of the 36 north-east Indian plants in Bailadila. For explaining the occurrence of these north-east Indian elements, Hora (1949) has recourse to his Satpura hypothesis when he says that though present-day topographic and climatic conditions are not favourable for the plants and animals of the Assam and the Eastern Himalayas to migrate to Chota Nagpur over the Rajmahal hills, the Satpura hypothesis postulates the existence of such favourable conditions over the intervening area in the Pliocene and Pleistocene times. Thus, Mooney presents evidence to show a northward migration from South India, while Hora postulates a southward migration from the north-east. As far as the present study is concerned, both views can be taken to be correct.

An example of a genus which is northern, but on the strength of present-day evidence appears to have produced at least a Section in the south, is *Youngia*. Babcock and Stebbins (1937) say that the distribution of the genus taken as a whole is entirely consistent with the conception that it is a natural group which had its origin in South-east Asia and that evolution has been accompanied by an extension of the geographic range to its natural limits on the south. The distribution of most species of *Youngia* overlaps in the area comprising Eastern Himalayas, Tibet, Assam, South-west China; and as such this area can be taken to be the place of origin for the genus. There are three species in South India:—

1. *Youngia fuscipappa* Thw., Western Ghats in Avalanche and Sispara in Nilgiris; Ceylon in highlands.
2. *Y. nilgiriensis* Babcock—Sispara in Nilgiris at about 2,060 m.
3. *Y. japonica* (L.) DC., subsp. *genuina* (Hochr) Babcock and Stebbins—Japan and Korea to West China, Malay Peninsula to North-west India; Philippines; North Circars in the hills of Ganjam, Western Ghats in the Nilgiris, Pulneys and hills of Travancore and Tinnevelley. Babcock and Stebbins (1937) say that this species is introduced widely in the tropics.

The first two belong to Section 5. Mesomeris of Babcock and Stebbins (1937), while the third belongs to Section 6. Euyoungia. *Y. nilgiriensis* is intermediate between *Y. gracilis* and *Y. cineripappa*, both of which belong to Section Mesomeris. Babcock (1939) who described the species *Y. nilgiriensis*, is of the opinion that several factors characterize it as a somewhat more primitive species than the others in Mesomeris. He suggests that its occurrence in an isolated highland may be due to its relict nature.

The diagnostic characters of the species *Y. nilgiriensis* indicate that it may probably represent an ancestral type from which the Section Mesomeris arose. If *Y. nilgiriensis* is the progenitor of this subsection of Mesomeris, it becomes necessary to believe that the progenitor ranged from the centre of the genus in the Sino-Himalayas right down to South India, and that changing climatic conditions have wiped out all its traces in the intervening areas. As to whether it originated in the north or the south it is not possible to decide on the strength of present data. The possibility of a southern origin of this subsection is a fascinating hypothesis which remains difficult of proof, but within the bounds of possibility.

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Summary

In the present study an analysis is made of the distribution of 370 plants occurring on hilltops in Madras State and Mysore, out of a total of 1,224 species so far reported.

The analysis is based on a division of India into 22 botanical provinces, and the occurrence of species in one or more of these.

Distribution patterns are adduced for groups of species, and these are indicative of routes of migration.

In the majority of the distribution patterns there is a distinct south to north-east trend.

The analysis reveals that the provinces Bihar and Orissa have played an important rôle in this north-south migration.

Possible routes of migration are indicated on the assumption that migration has occurred both ways. Examples are given.

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