CALOBRYALES : DISTRIBUTION AND PHYTOGEOGRAPHICAL DISCUSSION

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Abstract

The present paper provides the distributional pattern and phytogeographical considerations of the Calobryalean elements comprising of fourteen taxa including six species of genus *Calobryum* and eight of *Haplomitrium* in the world.

The Calobryales constitute one of the important orders of the Hepaticae and are significant both phylogenetically as well as phytogeographically. The taxa of this primitive order have drawn considerable attention of bryologists. Several aspects including morphotaxonomy, cytology and phylogeny of this group have been discussed by a number of workers (Lilienfeld, 1911; Berrie, 1959, 1962; Campbell D. H., 1920, 1935; Campbell, E. O. 1959; Grolle, 1963; Mehra, 1967, 69; Mehra and Kumar, 1980; Schuster, 1967, 71; Udar & Chandra, 1961, 65; Udar *et al.*, 1968; Kumar & Udar, 1976, 77; Udar & Kumar, 1980, 82; Udar & Singh, 1977; Udar & Srivastava, 1981), but the distributional and phytogeographical aspects have not yet received much attention except by Schuster (1972, 1983) who discussed it very briefly.

Recent studies of Indian Calobryales have revealed the occurrence of six species in India (see Udar, 1980). Of these *Haplomitrium* and *Calobryum* are represented by three taxa each, all confined to the eastern Himalaya exept *H. hookeri* which also occurs in the western Himalaya (Udar and Singh, 1977 ; Udar and Srivastava, 1981) making a total of fourteen taxa in the world (see Map 1) including *H. monoicum* recently described from New Caledonia (Engel, 1981). Majority of species of Calobryales are endemic to small geographical regions except one species of *Haplomitrium* (*H. hookeri*) and two species of *Calobryum* (*C. blumii* and *C. mnioides*) which show disjunct distribution.

Several studies (Campbell, 1907 ; Herzog, 1926; Steere' 1937, 1938 ; Sharp, 1938, 1941 ; Fulford, 1951, 1963 ; Schuster, 1958, 1962, 1967, 1969, 1972, 1983 ; Grolle, 1960, 1960a ; Hatcher, 1960) have attempted to demonstrate the variety of distributional patterns, extent of their ranges including the regional correlations, particularly of the leafy liverworts. Schutster (1958) pointed out some of the risks involved in the interpretations of the distributional patterns. The disjunct taxa either show trans-oceanic distirbution when occuring on land masses widely separated by vast stretches of oceanic barriers across which the dispersal of propagules is normally not possible, or they show trans-continental disjunction when they occur in regions far away from each other on more or less topographically continuous continents. The third pattern of disjunct distribution includes taxa with both trans-oceanic and trans-continental ranges. Disjunct taxa with all the above mentioned patterns are known in all the major groups of plants. In explaining the

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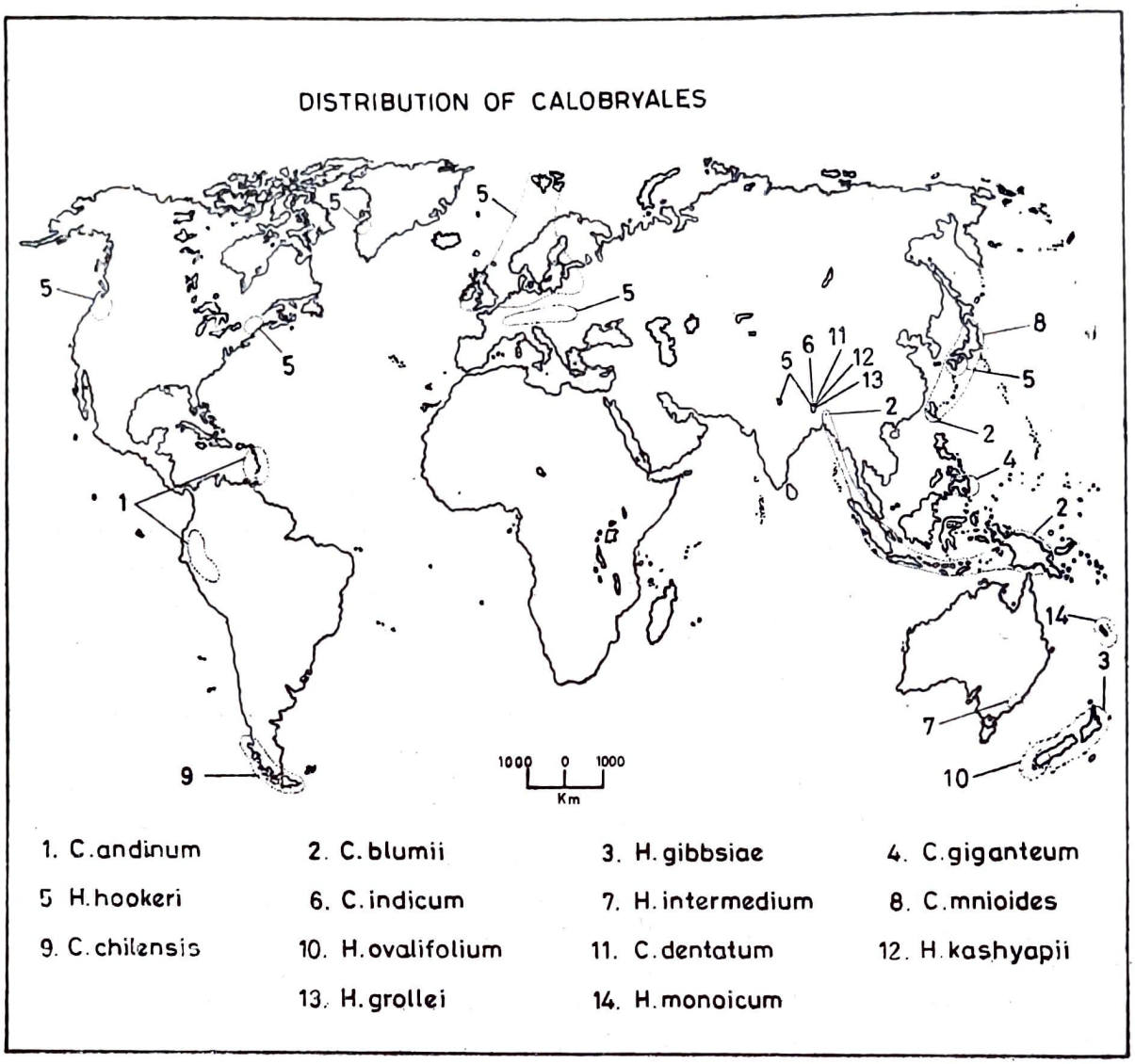

Map 1

trans-oceanic distribution of certain disjunct plants, concept of continental drift and theory of past land connections have invariably been employed. Fulford (1963) has explained the distribution of certain disjunct leafy liverworts in the Southern Hemisphere in the light of the concept of the continental drift.

Occurrence of such disjunct taxa in newly recorded regions, although extending their known distributional range, but still maintaining the distributional discontinuity, demands phytogeographical explanations with regard to their center of origin and the events resulting in their present distribution. Accordingly the Asiatic record of *Haplomitrium hookeri* from eastern Himalaya and of *C. blumii* from Meghalaya, India and *C. mnioides* from Taiwan necessitate some phytogeographical considerations.

H. hookeri shows very interesting disjunct distributional range extending from arctic zone to the lower limits of northern temperate zone. Several localities were listed in continents of Europe including Vice county Britain (Paton, 1964) and North America (Worley, 1969). The occurrence of *H. hookeri* in eastern as well as western Himalayas extends its range in northern temperate Asia. Phytogeographically, this taxon which was once a North

American-Eurpocan disjunct now shows a well defined North American-European-North-East Asiatic disjunct distribution.

The North American locality at New Hampshire is situated towards the eastern limits of the continents, of which side are the extensive ranges of Appalachian system and white mountain. North American locality at British Columbia, Glacier Bay, Alaska and northern Washington are situated towards the western limits of the continents. The West European localities, more or less, face the North American locality towards west and Arctic localities towrds North. Vast oceanic barrier of North Atlantic exists between North America, Britain and the continental Europe, Arctic Ocean separates spitsbergen from the rest. Europe and Asia together represent the largest land mass on the earth. The physical barrier of Ural mountain system serves for demarcation. The other intervening barriers of this land mass are those of Caspian Sea, Black Sea and Aral Sea. *Haplomitrium hookeri* shows trans-oceanic disjunction between Europe and North America and trans-continental disjunction between western Europe and North eastern Asia.

With the 'prima facie' we look into the past events leading to the present distributional pattern of *H. hookeri*. Schuster (1958, 1962) mentioned several liverworts occurring in eastern North America, mostly on Appalachian ranges with their extended ranges to the eastern Asia, particulary Japan. There are quite a number of Angiosperm genera with North American-Eastern Asiatic, North American-European-east Asiatic disjunct distribution. Gray (1846, 1860), Hooker (1878) and Fernald (1931) made comparative floristic studies of these distributional patterns. Gray (1846, 1860) held that most of the so called disjunct taxa are 'relics', in the sense that they are the members of the ancient continuous northern flora of Tertiary, which either survived Pleistocene glaciation at their original home or their migrations during the glaciation and post glaciation period resulted in their present disjunct distribution. Fernald (1925, 1929) clearly demonstrated the present disjunct distribution of arctic elements of once a continuous northern flora of Miocene in temperate and subtemperate regions of the northern Hemisphere. According to him many of the Southward migrating taxa of the northern flora during Pleistocene glaciation survived on high mountains serving as refugia or sheltered on unglaciated highlands the so called nunataks. From such refugia during post glaciation period, with the retreat of the ice line, plants still potent for travelling returned to or near their home localities through the same, or the other route. Some of the 'rigid' taxa with low 'migrating potential' thrived at different refugia in various directions as relics. Persistence, Southward migrations under the driving force of the Pleistocene glaciation along with the geographical changes in the northern land mass during Pleistocene-late Tertiary period are jointly responsible for the present disjunct distribution of the relics of the ancient Arctotertiary flora. These considerations when correlated with the distributional range of *H. hookeri* which is restricted to the northern Hemisphere, are suggestive of its center of origin in a nearctic zone, more or less, near to the present Scandinavian localities. From this possible zone it migrated southwards during the Pleistocene glaciation and survived at the Appalachian and allied refugia in the North American Zone, and in West European localities, it appears to be introduced through the invasion by the Southward migrating stock from Scandinavia. From central European region glaciation changed its course in South-east direction towards Asia. Pleistocene glaciation is quite evident in central North-eastern Asia particularly near the Pamir and Himalayan regions. The Tertiary and post Tertiary period witnessed many geological changes in Asia. The mountain ranges which meet in the Pamir knot is the result of powerful crust movements during the post Tertiary period (Wadia & West, 1964). In coincidence with the Pleistocene glaciation is the

third and the last uplift of the Himalayas, dated to be mid-Pleistocene (Karewa Series in Kashmir, vide Wadia & West, 1964). These facts show that before some of the running Arcto-Tertiary flora reached this region, refugia to shelter them were already there, which, later on the arrival of the migrants were occupied by them. This affords the possible explanation of the occurrence of *H. hookeri* in the Eastern Himalaya, India.

In nature, as is the case with many of the other relic taxa, *H. hookeri* shows very limited and suppressed power for expansion which may partly be attributed to senility. Senescence of this plant is further evident by: (a) phytogeographically it has been shown to be a relic taxon, (b) rarely forming compact populations, (c) in a given niche, being dominated by 2-3 populations of a more vigorous and dashing liverworts.

Other species of *Haplomitrium* are endemic to their particular small geographical region. *H. intermedium* distributed only in New South Wales, Australia, *H. gibbsiae* occurs only in New Zealand where it is throughout distributed in North and South Island, *H. ovalifolium* is reported from Campbell island, New Zealand and *H. monoicum* from New Caledonia only. *H. kashyapii* and *H. grollei* grow only in Darjeeling, Eastern Himalaya, India.

Similarly, like *Haplomitrium*, two species of *Calobryum*, viz., *C. blumii* and *C. mnioides* show the intra-continental disjunct distribution and others are endemic to their particular region. *Calobryum blumii* has been reported from Java, Sumatra and New Guinea (Schiffner, 1900 ; Stephani, 1898-1924 ; Grolle, 1964), Taiwan (Yang, 1966) and from Jowai (Meghalaya), India (Udar *et al.*, 1968). The sub-continents Java, Sumatra and New Guinea are separated from each other and also from Jowai (Meghalaya), India by oceanic barrier, i.e. Indian ocean. Another sub-continent, Taiwan is also separated by ocean barrier, i.e. Pacific ocean. Similarly *C. mnioides* is distributed in middle Japan as well as in Taiwan and these two sub-continents are also separated by Pacific ocean which forms a oceanic barrier. Thus *C. blumii* and *C. mnioides* show intra-continental and trans-oceanic disjunct distribution. Other remaining species are endemic. *C. andinum* is reported only from peru, Ecuador (South America) ; *C. giganteum* from Philippines, *C. chilensis* from Chile ; and *C. indicum* as well as *C. dentatum* only from Darjeeling, eastern Himalaya, India, that forms a small geographical region.

Thus, phytogeographically the eastern Himalaya, so far as the Calobryalean element is concerned, is very important and hosts six taxa out of the 14 up-to-date known species, of the order. Out of these six species, three belong to *Haplomitrium*, viz., *H. hookeri*. *H. kashyapii* and *H. grollei* and rest belong to *Calobryum*, viz., *C. blumii*, *C. indicum* and *C. dentatum*. And it is only in the eastern Himalaya in the world that both the genera viz. *Calobryum* and *Haplomitrium* occur and each with three species, several of which grow almost together at Darjeeling. The eastern Himlaya are thus highly significant in providing the most favourable climate and other ecological requirements needed for the luxurient growth of these taxa. The conclusion becomes irresistible that the eastern Himalaya may represent the center of origin for the Calobryales (see Udar, 1980).

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