Distribution of Indian Lepidoziineae *(Hepaticae)

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Out of a total of 31 genera of Lepidoziineae Schust. on the globe, only 7 viz., *Acromastigum* Evans, *Bazzania* S.F.Gray, *Dendrobazzania* (St.) Schust. *et* Schof. (*Subfam.* Bazzanioideae Rodw.), *Kurzia* V. Mart., *Lepidozia* (Dumort.) Dumort. (*Subfam.* Lepidozioideae Limpr.), *Metacalypogeia* (Hatt.) Inoue and *Calypogeia* Raddi with 33 taxa embracing the families Lepidoziaceae (the former five) and Calypogeiaceae (the latter two) occur in the Indian subcontinent. Significant variations have been noted in their distribution pattern. Some are restricted to one area or the other, while the rest are widely distributed within the country and also beyond the subcontinent, showing intercontinental floristic affinity. Of the 4 bryogeographical units of India, the East Himalayan territory is climatically most suited for the proliferation and differentiation of the taxa of Lepidoziineae to a maximum extent as evidenced by their richness both in frequency and variety. Over 90% (30 taxa) of the taxa are predominant in this territory (E.H.) followed by 33% (11 taxa) representation in South India (S.I.) and nearly 25% (8 taxa) in the West Himalayan territory (W.H.). The region of Central India, although believed to host an 'admixture' of the flora of the Himalayas and peninsular India intriguingly provides an environment seemingly not so conducive for the rapid proliferation of Lepidoziineae with a host of only one taxon. Out of the 33 taxa, 7 are endemic to India and 16 are known to occur only in Asia, while 10 show their extended distribution in other continents also. However, some elements of Lepidoziineae show intercontinental distribution.

Key-words: Bryophyta, Hepaticae, Jungermanniales, Lepidoziineae, India.

INTRODUCTION

THE Indian subcontinent, with its vast range of ecological and climatic diversity, is one of the richest 'treasure houses' of the Jungermanniales (leafy liverworts), an order that constitute the bulk (nearly 80%) of the total hepatic vegetation of the region. 'These diminutive standard of green' are either epilithic (saxicolous) and adorn, decorate and chequer the rocks and soil cover without concealing them, or, are epiphytic (corticolous) and either form a cushion or a blanket on a living phorophyte tree or a decaying stump or a fallen log.

The suborder Lepidoziineae Schust., one of the most important suborders of the leafy liverworts , is characterized by the general presence of microphylous flagelliform branches, restricted distribution of sex-organs on small, weak and abbreviated branches, and apparently constant, 'biphasic' development of the epidermal cells of the capsule wall. According to Schuster (1984), Lepidoziineae is represented on the globe by 31 genera falling under three families Lepidoziaceae Limpr. (28 genera), Calypogeiaceae H.W. Arn. (2 genera) and Phycolepidoziaceae Schust. (1 genus) (Fig. 1). In India the suborder is represented by only two families, Lepidoziaceae with 5 genera and Calypogeiaceae with 2 genera (Fig. 2).

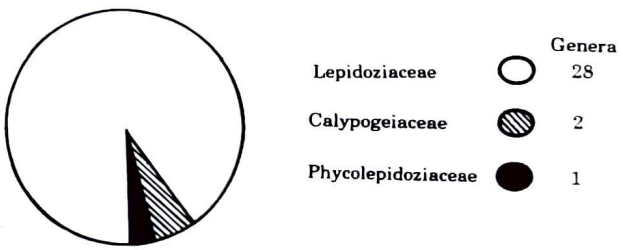

Fig. 1. Spectrum showing representation of Lepidoziineae on Globe

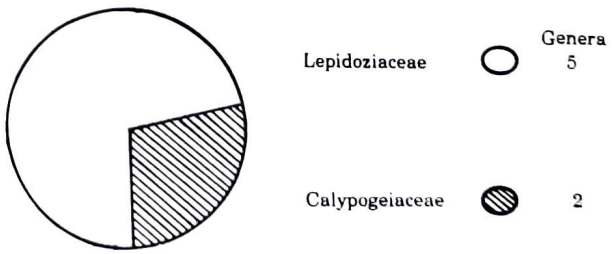

Fig. 2. Spectrum showing representation of families of Lepidoziineae in India

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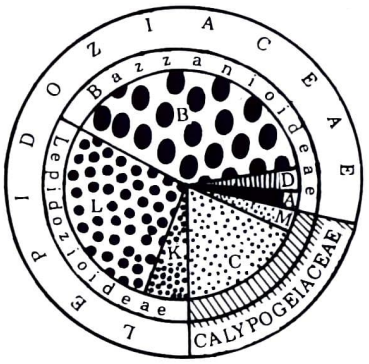
The large, natural family Lepidoziaceae includes plants which agree in having lateral-terminal branching and in developing postical (and sometimes lateral) flagella, incubously (rarely transversely) inserted, conspicuously 2-4 (or more) deeply or shallowly lobed to dentate leaves, isophyllous female inflorescence and a prominent, trigonous and gradually tapering perianth. The extremely polytypic Lepidoziaceae are subdivided into 8 subfamilies (Schuster, 1984), out of which only two are represented in India with five regional genera, namely : *Lepidozia* (Dumort.) Dumort, *Kurzia* v. Mart. (Lepidozioideae), *Acromastigum* Evans, *Bazzania* S.F. Gray and *Dendrobazzania* (St.) Schust. *et* Schof. (Bazzanioideae) (Fig. 3).



A - *Acromastigum* Evans
B - *Bazzania* S.F. Gray
C - *Calypogeia* Raddi
D - *Dendrobazzania* Schust. *et* Schof.
K - *Kurzia* v. Mart.
L - *Lepidozia* (Dumort.) Dumort.
M - *Metacalypogeia* (Hatt.) Inoue

Fig. 3. Spectrum showing representation of Lepidoziineae and its members in India

Calypogeiaceae is a nearly cosmopolitan family, having typically terrestrial marsupia bearing plants which are predominantly mesophytic or hygrophytic, the plants are distinctive with a rather translucent appearance, having usually postical-intercalary (rarely lateral-terminal) branching with almost horizontal, conspicuously incubous, entire or merely feebly bi-dentate leaves and the frequent appearance of microphyllous attenuate gemiferous shoots; the plants generally lack terminal branching and slender ventral flagella. The stenotypic family includes two genera, *Calypogeia* Raddi and *Metacalypogeia* (Hatt.) Inoue (Figure-3).

The representative taxa of the suborder have been variously treated and variable numbers have been reported by some earlier workers. In a recent monographic study of the suborder (Sharma & Srivastava, 1993) 33 taxa have been validly recognised from India. It includes nine species of *Lepidozia: L. robusta* St., *L. wallichiana* Gott., *L. udarii* Srivast. *et. al., L. flexuosa* Mitt., *L. minima* St., *L. brevifolia* Mitt., *L. stahlii* St., *L. erosa* St. and *L. reptans* (L.) Dumort.; two species of *Kurzia: K. makinoana* (St.) Gro. and *K. tenerrima* (Mitt. ex St.) Gro.; one species of *Dendrobazzania: D. griffithiana* (St.) Schust. *et* Schof., thirteen species of *Bazzania: B. assamica* (St.) Hatt., *B. sumbavensis* (Gott. ex. St.) St., *B. himalayana* (Mitt.) Hatt., *B. oshimensis* (St.) Horik., *B. orientalis* (St.) Parihar, *B. tridens* (Reinw., Bl. *et* Nees) Trev., *B.appendiculata* (Mitt.) Hatt., *B. sikkimensis* (St.) Herz., *B. ovistipula* (St.) Mizut., *B. imbricata* (Mitt.) Hatt., *B. tricrenata* (Wahlenb.) Lindb., *B. pearsonii* St., *B. praerupta* (Reinw., Bl. *et* Nees) Trev.; one species of *Acromastigum: A. inaequilaterum* (Lehm. *et* Lindenb.) Evans; one species of *Metacalypogeia: M. alternifolia* (Nees) Gro. and six species of *Calypogeia: C. arguta* Nees *et* Mont., *C. lunata* Mitt., *C. aeruginosa* Mitt., *C. marginella* Mitt., *C. fissa* (L.) Raddi and *C. azurea* Stotler *et* Crotz (Fig. 4).

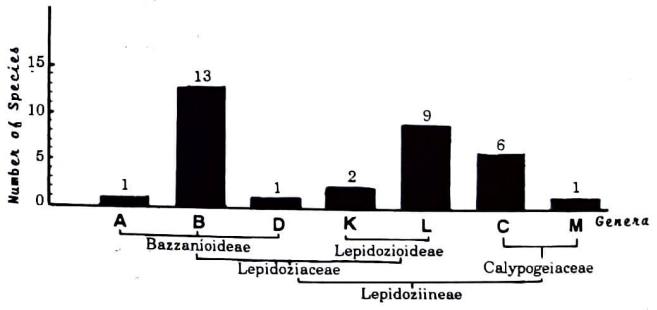


Fig. 4. Bar diagram showing number of taxa of Lepidoziineae in India

DISTRIBUTION

Distribution and vegetation of an area is subjected to modification by the adversities of the environmental factors, climate, geology and biotic factors. The Indian subcontinent with a wide range of diverse climates in different regions is reflected in its floristic diversity(see also Srivastava, 1998). Based on the bryophytic vegetation, the Indian subcontinent was earlier divided into four bryogeographical regions: (i) the Himalayan region including Western Himalaya and Eastern Himalaya, (2) the Punjab and the west Rajasthan Plains, (3)

Central India and the Gangetic plain and (4) Southern zone embracing West coast, East coast and Deccan plateau (Pande, 1958 see Maheshwari *et al.* 1965). Kachroo (1966), on the basis of the rainfall distributional curves, provided six divisions of the country namely the West Himalayan territory (20-200 cm), East Himalayan territory (200-300 cm), Punjab plains and Rajasthan (20-100 cm), Gangetic and Central India zone (100-200 cm), Peninsular India including West Coast (60-100 cm) and East Coast (100-400 cm). Regarding the distribution of the hepatic flora in India, Udar (1980) rightly remarked "The diverse climatic conditions of a vast country like India, support a luxuriant hepatic vegetation. It is significant that each part is characterised by their own distinctive flora apart from some common elements occurring in them. Of the above, it is only the West Himalayan territory and Punjab plains whose liverwort flora has been monographed in two volumes by Kashyap (1929, 1932). The flora of other parts await publication even though the East Himalayan territory and Southern Zone constitute the richest area of hepatic vegetation". The above statement is applicable to the distribution of the taxa of the suborder Lepidoziineae in India which show distinctive growth patterns in different bryogeographical areas except for the Punjab, West Rajasthan and Gangetic plains. Although the taxa of Lepidoziineae flourish throughout the country, but some are selective in their habitat and therefore, are restricted to one or the other locality. While some are widely distributed not only within the country but also beyond the subcontinent showing intercontinental floristic affinity. Each byryological region is characterised by some macro- and micro-climatic niches and supports a selective type of the elements of Lepidoziineae. The genera *Dendrobazzania* and *Kurzia* are confined to the east Himalayan territory while *Acromastigum* is restricted to Andaman and Nicobar Islands.

A study of the distributional pattern of the various taxa of Lepidoziineae clearly indicate that in terms of luxuriance and frequency the East Himalayan territory is floristically very rich and this possibly may be attributed to the maximum annual precipitation, low temperature and high degree of relative humidity in this region which facilitate the luxuriant representation of about 90% of taxa (30 taxa). This is followed by the South Indian territory hosting nearly 30% of the taxa (10 taxa) probably because it also receives high annual rainfall (almost paralleling the situation in the Eastern Himalaya) and warm climatic conditions. Cold and dry climate with less rainfall in the Western Himalaya also provide congenial conditions for the growth of certain Lepidoziineae, which is represented by 8 taxa in this region. It is intriguing that the conditions prevalent in Central India are not conducive for the growth and development of Lepidoziineae but for *Calypogeia arguta,* which is a sole representative growing in Pachmarhi, even though this territory is regarded to represent an "admixture" of the flora of Himalayas and Peninsular India (Pande & Srivastava, 1952) (Fig. 5).

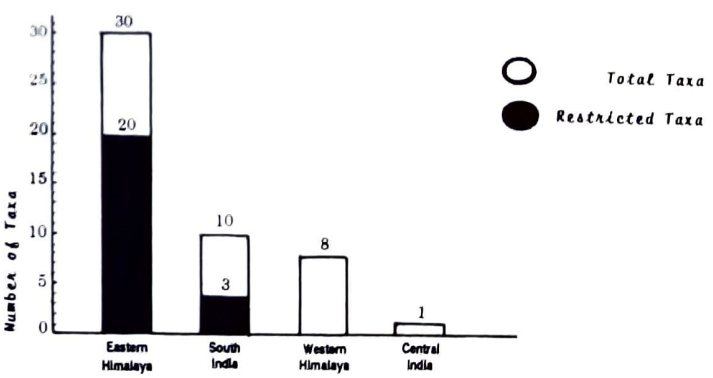


Fig. 5. Bar diagram showing distribution of representative taxa in four bryogeographial regions of India

Out of the 7 genera of Lepidoziineae in India the genus *Lepidozia* is restricted mainly to the Eastern Himalayas with all the 9 species, of which 6 are restricted to this region (3 also occur in the Western Himalaya and South India). The genus *Kurzia* is totally confined to the East Himalayan territory by two species. The monotypic genus *Dendrobazzania (D. griffithiana)* is also limited to this territory. *Bazzania* is more common in Eastern Himalaya with 11 out of 13 taxa found in this territory, of which 6 species are restricted to this territory only while 5 have an extended distribution to Western Himalaya and South India. Two species are

totally confined to South India. The genus *Acromastigum* with a single representative, is restricted to Andaman and Nicobar Islands of South Indian region. The genus *Metacalypogeia* is widely distributed throughout the Himalayan chain. The genus *Calypogeia,* hosting half a dozen species in India, is represented by all species in the East Himalayan region with half of the taxa restricted to this area, while the remainder show a wider distribution in other regions (Fig. 6).

The following distributional patterns are noted among Indian Lepidoziineae.

West Himalayan taxa: Out of the bulk of 33 taxa about 24% (8 taxa) comprising three species of *Bazzania,* two species each of *Calypogeia* and *Lepidozia* and one of *Metacalypogeia* are found to be proliferating in this area (Figure-6), which include *Bazzania imbricata, B. praerupta, B. tricrenata, Calypogeia azurea, C. lunata, Lepidozia brevifolia, L. reptans* and *Metacalypogeia alternifoila.* Of the above none is confined to this area (Figs. 7, 8, 9 and 10).

East Himalayan taxa: In the east Himalayan region the Lepidoziineae reaches to its zenith of representation as is evidenced by the occurrence of 90% (30 taxa) of the taxa. This number includes 11 species of *Bazzania,* 6 species of *Calypogeia,* 1 species of *Dendrobazzania,* 2 species of *Kurzia,* 9 species of *Lepidozia* and 1 species of *Metacalypogeia* (Figure-6). The taxa occurring in this region are as follows **Bazzania appendiculata, *B. assamica, *B. himalayana, B. imbricata, B. ovistipula, *B. pearsonii, *B. praerupta, *B. sikkimensis, *B. sumbavensis, B. tricrenata, B. tridens, *Calypogeia aeruginosa, C. arguta, C. azurea, *C. fissa, *C. lunata, *C. marginella, *Dendrobazzania griffithiana, *Kurzia makinoana, *K. tenerrima, Lepidozia brevifolia, L. erosa, L. flexuosa, *L. minima, L. reptans, L. robusta, *L. stahlii, *L. udarii, *L. wallichiana* and *Metacalypogeia alternifolia.* Of the above 60% (18 taxa) are restricted (*) to this region, while a dozen (34%) taxa exhibit their extended range of distribution. (Figs 7, 8, 9 and 10).

South Indian taxa : South Indian zone stands second in the distributional pattern by hosting 30% (10 taxa) of the Indian Lepidoziineae. The representatives occurring in this region include one species of *Acromastigum,* five species of *Bazzania,* and two species each of *Calypogeia* and *Lepidozia* (Figure-6). These are *Acromastigum inaequilaterum, Bazzania orientalis, B. oshimensis, B. ovistipula, B. praerupta, B. tridens, Calypogeia arguta, C. azurea, Lepidozia erosa* and *L. reptans,* Only 9% (3 taxa) are found to be restricted to this region, which are *Acromastigum inaequilaterum, Bazzania orientalis* and *B. oshimensis* (Figs. 7, 8, 9 and 10).

Central Indian taxa - This region provides a comparatively less congenial climate for the growth of Liverowrts (Pande and Bharadwaj 1952; Udar 1976) which is also evidenced by the near absence of Lepidoziineae in this area, except for *Calypogeia arguta* (Figs. 6, 7 and 10).

Taxa with extended range of distribution - This category includes 36% (12 taxa) of the Lepidoziineae which have found a congenial habitat for their growth in more than one bryogeographical units of India and they can be further grouped under:

1. Taxa common to Eastern and Western Himalayas : *Calypogeia lunata, Bazzania imbricata, B. tricrenata, Lepidozia brevifolia* and *Metacalypogeia alternifolia.*
2. Taxa common to Eastern, Western Himalayas and South India: *Bazzania praerupta, Calypogeia azurea* and *Lepidozia reptans.*
3. Taxa common to Eastern Himalaya and South India : *Bazzania ovistipula, B. tridens* and *Lepidozia erosa.*
4. Taxa common to Eastern Himalaya, South India and Central India : *Calypogeia arguta.*

Endemic Taxa- Out of the total 33 taxa of Indian Lepidoziineae, about 21% (7 taxa) are endemic to the different regions of the subcontinent (Figure-11) namely, *Bazzania orientalis* (South India (*Calypogeia aeruginosa, C. marginella, Kurzia tenerrima, Lepidozia minima, L. udarii* (Eastern Himalaya) and *L. brevifolia* (Eastern and Western Himalayas).

Taxa with wider distribution beyond the Indian subcontinent-

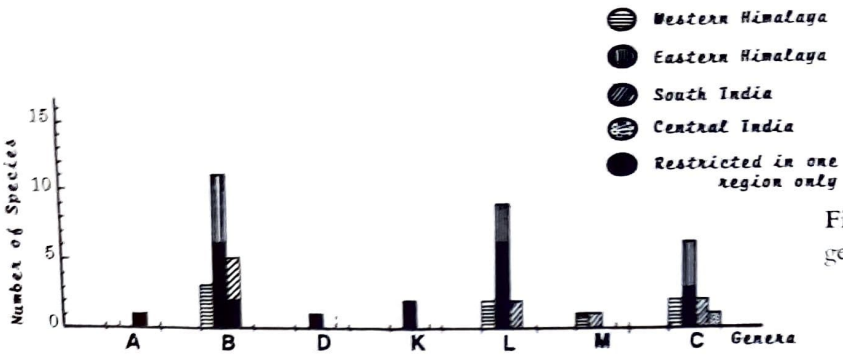


Fig. 6. Bar diagram showing distribution of various genera in different Bryogeographical regions of India

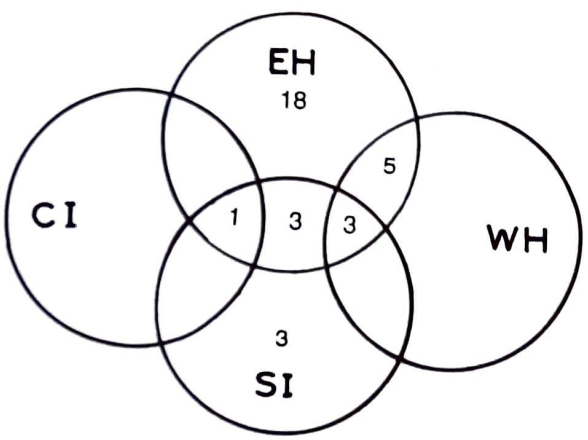


Fig. 7. Venn diagram showing distribution and range of extension of Lepidoziineae in India

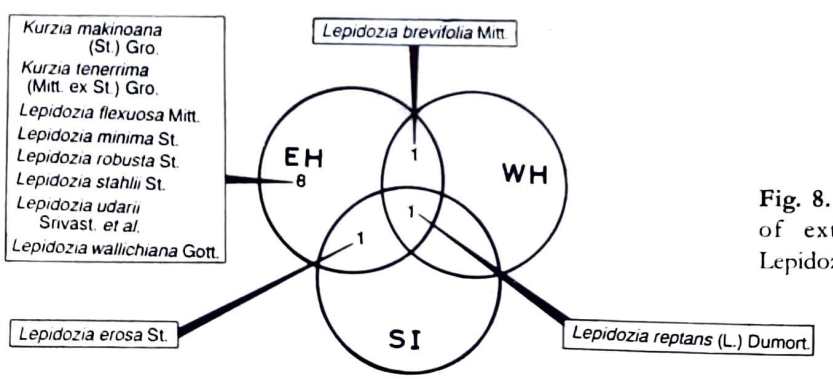


Fig. 8. Venn diagram showing distribution and range of extension of taxa belonging to Subfam. Lepidozioideae in India

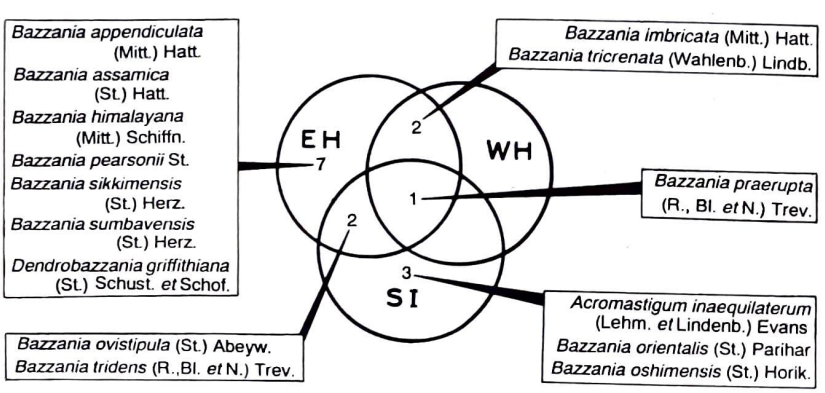


Fig. 9. Venn diagram showing distribution and range of extension of taxa belonging to Subfam. Bazzanioideae in India

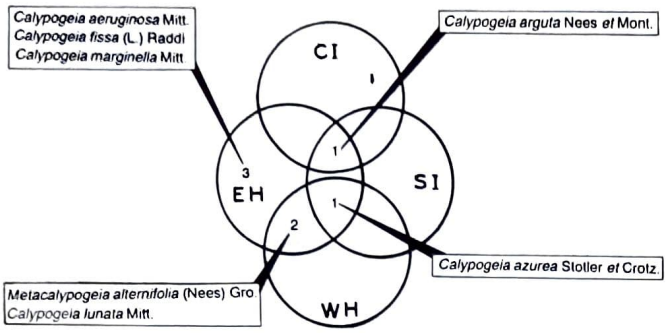


Fig. 10. Venn diagram showing distribution and range of extension of taxa belonging to Family Calypogeiaceae in India

This category includes 79% (26 taxa) representatives of the suborder, of which the majority, 40% (16 taxa) are confined to Asia only, namely, *Acromastigum inaequilaterum, Bazzania appendiculata, B. assamica, B. himalayana, B. imbricata, B. oshimensis, B. ovistipula, B. sikkimensis, B. sumbavensis, B. tridens, Calypogeia lunata, Lepidozia erosa, L. flexuosa, L. robusta, L. stahlii* and *L. wallichiana.* Three taxa show an extended distribution to Asia and North America, viz. *Bazzania praerupta, Dendrobazzania griffithiana* and *Metacalypogeia alternifolia. Calypogeia fissa* is found in Asia, Africa and Europe, while three taxa, *Calypogeia arguta, C. azurea* and *Lepidozia reptans* are found to be growing in the continents of Asia, Africa, America and Europe (Fig. 11).

PHYTOGEOGRAPHY

Recently Long and Grolle (1990) have reported several distribution patterns for the Hepatic flora of Bhutan, the same distributional criteria have been adopted here, while discussing the phytogeographical distribution of the Indian representatives

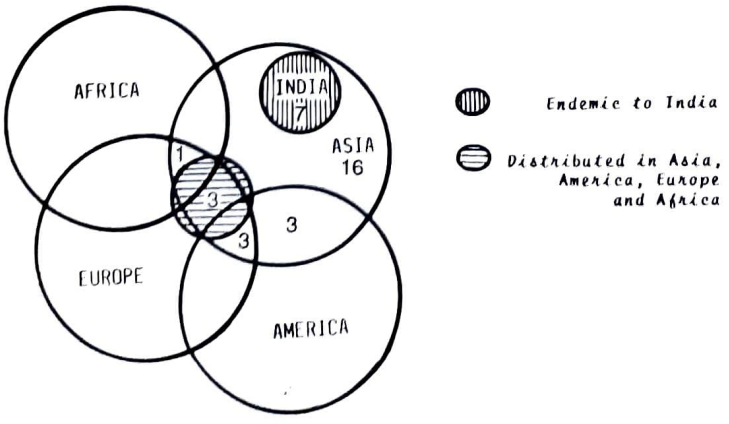


Fig. 11. Venn diagram showing intercontinental range of distribution of Indian Lepidoziineae

of Lepidoziineae.

Eastern Asiatic Element : This element comprises taxa restricted to the eastern Asia, which includes the Indian subcontinent, China, Indo-China, Malaysia, Indonesia and New Guinea. More than 50% (17) taxa fall into this category, as either the inhabitants of Temperate or Tropical, or both of the regions. *Calypogeia lunata, Bazzania imbricata* and *Lepidozia robusta* are disjunct temperate Asiatic taxa that occur in East Himalaya (often with a restricted range) and another disjunct region in China, Taiwan or Japan. *Metacalypogeia alternifolia* is found widespread in temperate Eastern Asiatic zone occurring in Himalaya, China and Taiwan. Tropical eastern Asiatic elements include the species growing in subtropical forests of India and have a more southern distribution to South East Asia, extending to Borneo, Myanmar (Burma), Sumatera (Sumatra), Thailand, Malaya and often to New Guinea. *Acromastigum inaequilaterum, Bazzania assamica, B. ovistipula, B. praerupta, B. sikkimensis, B.sumbavensis* and *Lepidozia flexuosa* have a widespread range, while *Lepidozia stahlii* has a disjunct distribution in India, Bhutan and Java. Five taxa, *B. appendiculata, B. himalayana, B. oshimensis, B. tridens* and *Lepidozia wallichiana* are widespread and common to both temperate and tropical eastern Asiatic regions of the world growing in Amboina, Bangka, Bhutan, Celebes, Ceram, Ceylon, Japan, Java, Nepal, Philippines, Samoa, Sumatera, Taiwan and Thailand.

Northern Hemisphere Element: This category includes about 21% (7) taxa of the Indian Lepidoziineae growing widespread in the northern half of the globe, these are, *Bazzania pearsonii, B. tricrenata, Calypogeia arguta, C. azurea, C. fissa, Kurzia makinoana* and *Lepidozia reptans.*

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REFERENCES

Kachroo, P. 1966. Taxonomy of Indian Hepaticae since Mitten-A comment. *Symposium Bryology*, Chandigarh.

Kashyap, S.R. 1929. *Liverworts of the Western Himalayas and the Panjab Plain I,* 1-129. The University of Panjab, Lahore.

Kashyap, S.R. 1932. *Liverworts of the Western Himalayas and the Panjab Plain II* 1-137. The University of Panjab, Lahore.

Long, D.G. & Grolle, R. 1990. Hepaticae of Bhutan II. *Journ Hattori Bot. Lab. No. 68 :* 381-440.

Maheshwari, P., Sengupta J.C. & Venkatesh C.S. 1965. Flora. In: The Gazetteer of India Vol. *I* pp. 163-229.

Pande, S.K. 1958. Some aspect of Indian Hepaticology *J.Indian bot. soc. 37 :* 1-26.

Pande, S.K. & D.C. Bharadwaj. 1952. The present position of Indian Hepaticology with a note on the Hepatic vegetation of the country. *The Palaeobotanist 1* : 368-381.

Pande, S.K. & K.P. Srivastava 1952. The hepatic vegetation of Pachmarhi (Madhya Pradesh): A preliminary survey. *J. Indian bot. Soc. 31* : 342-351.

Sharma, D. & S.C. Srivastava. 1993. Indian Lepidoziineae (A Taxonomic Revision). *Bryophytorum Bibliotheca Band 47.* Berlin. Stuttgart.

Schuster, R.M. 1984. Evolution, Phylogeny and Classification of the Hepaticae. *In : New Manual of Bryology 2 :* 892-1070. The Hattori Botanical Laboratory, Nichinan.

Srivastava, S.C. 1998. Distribution of Hepaticae and Anthocerotae in India. *In : Topics in Bryology* (Ed. R.N. Chopra). Allied Publishers Limited. New Delhi

Udar, R. 1976. *Bryology in India. Ann. Cryptog. Phytopathol.* The Chronica Botanica Co., New Delhi.

Udar, R. 1980. Taxonomy of Indian Hepaticae *In : Glimpses in Plant Research* Vol. 5 : Modern Trends in Plant Taxonomy (Ed. P.K. Nair) : 70-84.

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