BULL. BOT. SURV. INDIA
Vol. 25,Nos. 1-4 : pp. 19-25, 1983

A REVIEW OF THE TRIBE VERNONIEAE (ASTERACEAE) IN SOUTH INDIA

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ABSTRACT

The tribe Vernonieae of the Asteraceae with about 70 genera and 1500 species has two main centres of distribution in tropical America and tropical Africa. It is also fairly well represented in south-east Asia. 37 genera are monotypic. In South India about 50 species belonging to 5 genera have been recorded. This review makes a current assessment of the systematic status of the tribe from various points of view, morphology-anatomy, cytology, chemical constituents, geographical distribution, based on a recent study of the tribe by one of the authors. It has been shown that some of the morphological-anatomical attributes like, trichomes, stomata, pappus, inflorescence, cytological situation as revealed by a karyomorphological analysis, chemical constitutes like flavonoid compounds and geographical distributional features, may all be of value in the assessment of the systematic status of the taxa concerned. Some nomenclatural aspects have also been discussed.

INTRODUCTION

The tribe Vernonieae of the Asteraceae includes about 70 genera and 1500 species. 37 genera are monotypic. The tribe is largely tropical with two main centres of distribution, one in tropical America, particularly in southern Brazil and the second in tropical Africa. It is also represented in south-east Asia. In South India, about 50 species have been recorded. *Vernonia*, with about 1000 species, is the largest genus, predominantly tropical in distribution ; 400-500 species are found in the New World and about the same number in the Old World. It has been stated that *Vernonia* forms the central core of the tribe, with the smaller genera appearing to radiate from it (Jones 1979). In recent years Jones and his associates have contributed significantly to our knowledge of the Vernonieae, particularly of the New World species. The African species have also been the subject of extensive studies. The South Indian species have not received sufficient attention. This review is based mostly on a recent study of the morphology, leaf anatomy, cytology, flavonoid content, geographical distribution and taxonomy of the South Indian Vernonieae by the second author (Narayana 1981 b) and presents a picture of the present situation of the group in the region.

REVIEW OF LITERATURE

An extensive literature has been built around the Asteraceae which are perhaps the most highly specialized plants among the dicotyledonous Angiosperms. The recent international symposium held in Reading, England, on the biology and chemistry of the family, the proceedings of which have been published in two volumes (Heywood *et al.* eds. 1977), highlighted the significant researches that have been conducted on the group. An overview of the subject is given by Heywood, Harborne and Turner in the introductory chapter of the first volume. The tribe, Vernonieae has been reviewed by Jones (1977) regarding its systematic, biological and evolutionary aspects, while the chemical

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aspect has been reviewed by Harborne and Williams (1977).

Hooker, in his Flora of British India (1881), described 23 species belonging to 5 genera from South India. Clarke (1876), in his conspectus of the Compositae of India, had also described the species which formed the basis for Hooker's account. Gamble (1921) and Cooke (1908), in their accounts of the Compositae, in the regional Floras of Madras and Bombay Presidencies, included some additional species. Fischer (1940) described two new species of *Centratherum* and *Vernonia* of which, one endemic species from Anamalai Hills, had been named earlier by Beddome and validated by Gamble (1920). This species, *Vernonia anamallica* Bedd. ex Gamble, is now considered a rare and threatened species of the region (Henry *et al.* 1978). In recent years, Shetty and Vivekananthan (1970) have described a new species, *Vernonia anaimudica* from Kottayam District in Kerala. Narayana (1981a) has very recently described a new *Phyllocephalum*, *P. sengeltherianum* from Tamil Nadu (all the Centratherums of earlier literature from India are now treated under *Phyllocephalum* Bl.). With these additions, the total number of species of Vernonieae occurring in the region comes to about 50.

MORPHOLOGY AND ANATOMY

The morphology and anatomy of selected Vernonieae have received the attention of many workers. Jones (1977) has reviewed the recent literature in this regard. It has been stated that the inflorescence types, trichomes, venation and epidermal features may have systematic value. Cabrera (1944), working on the Vernonieae of Argentina, compared the leaf anatomy, glands, trichomes, pollen grains, corollas, stamens, styles, achenes, pappus and inflorescences of selected species of the tribe and demonstrated the systematic value of the inflorescence types, confirming Gleason's (1923) earlier observations. Jones (1973) examined the trichomes, venation and epidermal structures of cleared leaves of *Vernonia* sect. *Eremosis* and found taxonomically useful features. Narayana (1979a, 1981b) studied trichomes of 20 species of the 5 genera occurring in South India and described the trichome characters in them. Each genus can be distinguished on the basis of its characteristic trichome. The trichome feature can also be employed in distinguishing closely related species. For example, *Vernonia monosis* and *V. arborea* have been treated as conspecific by some authors but they can be easily distinguished on the basis of their trichomes : *V. monosis* has biseriate, vesicular glandular hairs on the fruit wall while they are absent in *V. arborea*. Biseriate forked hairs are present on the pericarp of *V. arborea* whereas biseriate non-forked hairs occur in *V. monosis*. Narayana (1981b) has also shown that the trichome complement of *Centratherum anthelminticum* simulates that of *Vernonia* and not of *Centratherum*. This is one of the evidences to show that the treatment of *Vernonia anthelminticum* under *Centratherum* by Kuntze and others is not justified.

Species of South Indian Vernonieae do not show much variation in stomatal types but the frequency and stomatal indices are variable. All plants studied (Narayana 1981b) exhibit anomocytic stomata except *Elephantopus scaber* where anisocytic type is seen. All Phyllocephalums except *P. scabridum*, *Adenoon indicum* and *Elephantopus scaber* are amphistomatous. *Lamprachaenium microcephalum* and *Vernonia* spp. except *V. albicans* and *V. anthelmintica* are hypostomatous. Observations made on the epidermal cells from the plants of green houses and from those collected in the field under different ecological conditions revealed (Narayana 1981b) that the nature of epidermal walls and type of stomata were constant for each species and are thus dependable characters for taxonomic consideration.

The characters of lamina such as mesophyll, sclereids and venation pattern have

been considered as distinguishing features of different taxa (Narayana 1981b). For example, the double-layered epidermis, bullate nature of the lamina and presence of oil glands are not found to occur in any other species of the group except in *Vernonia comorinensis*. *V. peninsularis* and *V. saligna* var. *nilgherensis* can be distinguished by the nature of their mid-vein termination. *V. ramaswamii*, *V. elaeagnifolia* and *V. cinerea* resemble tree forms in having penicillate type of mid-vein end. *V. albicans* is unique in having dichotomously branched mid-vein tip. In the presence of foliar sclereids, *V. albicans* and *V. setigera* resemble each other but differ from *V. cinerea* and *V. conyzoides*, although all the four are morphologically similar.

The pappus is another morphological entity deserving consideration in the characterisation of the species of *Phyllocephalum* and *Vernonia*. For example, in the genus *Phyllocephalum*, some species have only a few pappus and others have copious pappus. This is considered a Key character and species with such a distinct character cannot be reduced to a conspecific status. Kirkman (1981) probably did not consider this feature while reducing the Indian species of *Phyllocephalum* to only two species. In Vernonieae, totally four types of pappus have been recognized.

The receptacle, in the tribe Vernonieae, is of the naked type. This naked receptacle exhibiting a particular architecture is of taxonomic importance. Among the Vernonias of South India, eleven types have been observed (Narayana 1981b). In most of them, the receptacle is of the *fimbrillate* type. *Vernonia anthelmintica*, *V. bababudensis* and *V. comorinensis* are exceptions in having *scrobiculate*, *areolate* and *falsifoveolate* types respectively. Similarly, among the species of *Phyllocephalum*, *areolate* type occurs in *P. scabridum* and *P. rangacharii*, *fimbrillate* type in *P. courtallense* and *P. sengeltherianum*, while *P. phyllolaenum* and *P. tenue* possess *glandulofoveolate* and *glandulo-pitted* types respectively. *P. mayurii* and *P. ritchiei* show the *glandulo-areolate* type. These are distinctive for the respective species. *Adenoon* and *Lamprachaenium* are characterised by the occurrence of *pilose* and *foveolate* types respectively.

Small (1918), while making phyletic consideration of the various groups of the family, concluded that the *foveolate* type was primitive and the *alveolate* and *setiferous* types advanced. Though his conclusion may not be universally acceptable, the feature serves in taxonomical delimitation as an additional character.

Narayana (1981b) has recently shown the value of the features of involucral bracts as useful taxonomic criteria. In the Vernonieae of South India, the involucral bracts are multiseriate. In all species of *Phyllocephalum*, the outermost leafy bracts are very conspicuous. They resemble the sessile leaves or calyculus. The cordate bract of *P. ritchiei* does not occur in any other species. Other species of the genus show resemblances and differences in their bracts to varying degrees. In *Vernonia*, foliar bracts are not generally seen but *V. anthelmintica* exhibits spathulate bracts. The involucre of all the tree Vernonias and *V. elaeagnifolia* is of the tubular type, with simple reduced bracts. *Lamprachaenium* resembles *Phyllocephalum* in having foliar bracts. *Elephantopus scaber* has a glomerule formed by a number of small capitular aggregations within two or three large spathaceous structures thus resembling the genus *Lychnophora* of the American region. This feature was taken as the basis for the division of the tribe Vernonieae into Euvernonieae and Lychnophoreae by earlier systematists.

In a recent study of the structure and development of the seed coat and fruit wall, Rajashekara (1981) has observed, among other things, the presence of schizogenous air spaces in the tissue of the ovary wall in *Vernonia divergens*, globular, glandular cells in the epidermis of the pericarp of *Vernonia*

albicans, V. conyzoides, V. cinerea, V. divergens and *V. elaeagnifolia.* A similar condition is also seen in *Elephantopus scaber.* Jones (1977) has pointed out that external features of the pappus and achenes when examined by both LM and SEM provide good markers for certain African genera. Such studies are needed for the large genera like *Vernonia* and particularly for those occurring in the South Indian region.

POLLEN

Skvarla *et al.* (1977) have recently reviewed the pollen morphology in the Compositae. They have alluded to remarks of Wodehouse (1935) who had stated that the pollen morphology of Vernonieae was highly distinctive because of its lophate nature and that the lophate character, when present, is of the highest phylogenetic value. The importance of pollen morphology in resolving certain taxonomic problems at the infra-generic level has been pointed out by Keeley and Jones (1979). They have discussed, on worldwide basis, the prevalent types of pollen grains in the genus *Vernonia* and have recognized six types among them. They had earlier (1977) stated that "pollen morphology was consistent at the sub-sectional level in the West Indian *Vernonia* and that species groups established on the basis of pollen morphology correspond closely to those erected on more traditional megamorphological grounds". The genera *Centratherum* Cass. and *Phyllocephalum* Bl. have been separated by Kirkman (1981) based on the two types of pollen grains in them. This is also geographically correlated with chromosome numbers. These two genera had been treated as congeneric by earlier systematists like Bentham. Chaubal and Deodikar (1965) described pollen morphotypes of the five genera represented in South India and Vasanthy (1976) described the pollen morphology of *Centratherum* and *Vernonia.* More critical studies utilising modern methodologies including SEM are needed for the proper understanding of the pollen of the South Indian Vernonieae.

CYTOLOGY

There have been comparatively few studies on the cytology of the South Indian Vernonieae. The cytological data that is available is meagre and the few that are available deal mostly with the chromosome counts. Mathew and Mathew (1976) made a karyological investigation of seven species of South Indian *Vernonia.* The occurrence of chromosomal variability in *Elephantopus scaber* was attributed to a somatic reduction by Rangaswamy Ayyangar and Sampathkumar (1967), who also observed the tetrasomic chromosome complement in the normal diploid root tips and promiscuous distribution of chromosomes in them. Narayana (1979b, 1981b) has given a detailed karyomorphological analysis of eight species of *Phyllocephalum,* five species of *Vernonia* and of *Adenoon indicum* and the monotypic genus *Lamprachuenium.* Based on these studies he concluded that cytologically, the species of South Indian Vernonieae fall under two basic series, $x = 9$ and $x = 10$, of which the former series showed greater preponderance. Polyploids have been derived from both the series but are comparatively smaller in number. All the tree Vernonias of the region are hexaploids. The presence of satellited chromosomes helps to distinguish *Vernonia conyzoides* from the morphologically and karyomorphologically similar *V. cinerea.* The chromosome number is uniformly $2n = 18$ in *Phyllocephalum* but the karyotype is characteristic for each species. On a cytological basis, the species of *Phyllocephalum,* previously recognized under the genus *Centratherum,* are distinct and need not be reduced to only two species as done by Kirkman (1981).

CHEMICAL CONSTITUENTS — FLAVONOIDS

Narayana (1980, 1981b) has recently made a survey of the South Indian Vernonieae for flavonoid pigments, employing paper chro-

matographic methods. He examined 5 genera and 31 species of the tribe. The results have been utilized by him to correlate and compare with the morphological and cytological data obtained on them for assessing their systematic status. Flavonoid spots revealed characteristic spot-pattern for the genera and species. A specific pattern of four spots with different Rf values was noted in *Phyllocephalum* species. In the genus *Vernonia* flavonoid pattern was found to correlate with the habits of plants although the shrubby forms do not conform in this regard. Tree Vernonias are characterized by the occurrence of four BG spots in linear order at one corner of the chromatograms. The herbaceous species are distinguished by the presence of three common spots. Based on the concept of Bate-Smith (1963) that leuco-anthocyanidins occur more commonly in the tissues of woody plants than in herbaceous ones, the situation in tree Vernonias was examined and the absence of these compounds in them leads to the conclusion that the woody habit in Vernonieae is a secondarily derived one. Narayana (1981b) has also studied the free-amino acid pattern in fifteen species of the tribe. The genera *Adenoon*, *Elephantopus* and *Lamprachaenium* exhibited their individual distinctive patterns and this feature is correlated with the situation in respect of flavonoid compounds in these genera.

GEOGRAPHICAL DISTRIBUTION

The tribe Vernonieae is well represented in the tropics of South America and Africa. Many of its members are also found in south-east Asia, West Indies and in eastern United States. In Africa they grow in Savannas, south of Sahara and extend to South Africa. In south-east Asia, the Vernonieae are limited to tropical and semi-tropical regions. In South India, nearly 50 species have been recorded and most of them are confined to hilly regions, except *Vernonia anthelmintica*, *V. cinerea*, *V. cinarescens*, *V. elaeagnifolia* and *Phyllocephalum scabridum*. About fifty percent of the recorded species are found in the hills of Tirunelveli in Tamil Nadu. Some of the species are very rare and have attained a state close to extermination (*see* Henry *et al.* 1978). Of the 37 monotypic genera in the tribe, 2 are found in South India, *Adenoon* and *Lamprachaenium*. *Adenoon* with an Indo-Malaysian distribution is restricted in the region to Kodachadri, Brahmagiri and Mahabaleshwar Hills at altitudes, 1500-2000 m on exposed grassy peaks. *Lamprachaenium* is recorded from Mahabaleshwar and Bababudangiri Hills at 1500 m altitude, in the shade of orophytic forests.

Tirunelveli Range in Tamil Nadu is an important distributional centre for the genera *Vernonia* and *Phyllocephalum*. Anaimudi Peak, the Palni Hills and Cardamom Hills (in the High Range of Travancore in Kerala) form another prominent region which accommodates several endemic species like *Vernonia anaimudica*, *V. anamallica*, *V. pulneyensis* and *V. fysonii*. *V. shevaroyensis* is endemic to Shevaroy Hills of Yercaud in Tamil Nadu. A detailed phytogeographical analysis undertaken by Narayana (1981b) has revealed that the South Indian Vernonieae, with the exception of the weedy and widespread species, have limited amplitude and many of them are restricted to hilly regions. Any disturbance caused to these habitats by the indiscriminate exploitation of the forests will lead to the elimination of these species.

SYSTEMATIC CONCLUSIONS

A taxonomic survey of the tribe Vernonieae in South India has revealed that at present there are about 50 species belonging to 5 genera in the region. Three of the genera, *Elephantopus*, *Adenoon* and *Lamprachaenium* are represented by a single species, the latter two being monotypic. In a recent world revision of *Centratherum*, Kirkman (1981) has pointed out that the genus

Centratherum as defined by Bentham (Gen. Pl. 2:225.1873) has in fact two types of pollen grains "geographically correlated with chromosome numbers" suggesting thereby that the genus is heterogeneous. She has, therefore, concluded from the evidence she has been able to gather from pollen grain morphology, chromosome numbers, geographical distribution and morphological differences that the name *Centratherum* should be used for the species from the New World, Australia and Philippines, while those from India and Java are to be treated under *Phyllocephalum* of Blume (Bijdr. 888. 1825). It is of interest to note that De Candolle (Prodr. 5:70.1836) had excluded the Old World species from *Centratherum* and placed them under genus *Decaneurum*. Blume, a few years earlier, had erected a genus *Phyllocephalum* with the same circumscription and as such Blume's name has to be adopted for the Old World genus. The species of *Centratherum* occurring in South India are, therefore, now treated under *Phyllocephalum*. Kirkman (1981) recognizes only two species from the region, *P. scabridum* (DC. in Wt.) Kirkman and *P. indicum* (Less.) Kirkman, reducing all other species to synonymy under either of these two. Narayana (1981b) has, however, in his detailed study of various aspects of morphology, anatomy and cytology of these species, obtained evidence to support the retention of most of them under their original specific identity. New combinations under *Phyllocephalum* for such species wherever necessary have been made (Narayana 1982). The genus *Phyllocephalum* as now recognized is reported to have 11 species from South India (Hooker 1881, Gamble 1921). Narayana (1981b) who made an extensive field study in the region was not able to collect *P. metzianum* and *P. hookeri* nor could he examine any herbarium specimen of these species. He was not, therefore, able to assess their taxonomic status and as such they have been retained in synonymy as per the treatment of Kirkman. Species like *P. mayurii*, *P. ritchiei* and *P. tenue* are confined to the Concan region and they are strict annuals, thriving during the monsoon months. *P. rangacharii*, *P. courtallense*, *P. sengeltherianum* and *P. indicum* exhibit suffrutescent habit and are seen only in Tirunelveli Hills, Anamalai and Nilgiri Hills. *P. scabridum* and *P. phyllolaenum* occur in both regions though they are strict annuals.

As elsewhere, *Vernonia* has the largest number of species in the region. 37 species are on record from published literature but Narayana (1981b), in his recent study, has reduced one of them *V. dalzelliana* Drumm. & Hutch. to synonymy under *V. ornata* Talb. In spite of his best efforts, he was not able to collect *V. meeboldii* W. W. Sm., *V. membranacea* Bedd. ex Moore, *V. multibracteata* Gamble, *V. pulneyensis* Gamble and *V. recurva* Bedd. ex Moore or locate specimens of them in the herbaria accessible to him. The specific delimitations of the genus *Vernonia* in India were stated to be obscure by Hooker (1881). Some clarification in this regard, based on the study of various aspects, has been provided by Narayana (1981b) who has also given detailed descriptions for the species studied by him.

The genus *Vernonia* is considered to provide an ideal system to obtain cytogenetic information on a tropical genus (Jones 1976) and several studies have been carried out for the New World taxa in this regard. Experimental and extensive field studies are indicated to assess the cytogenetic status of the Vernonias of the South Indian region.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the authorities of the University of Mysore for accommodating them and providing facilities in the Department of Botany, Manasagangotri for this work and to the University Grants Commission for financial support under the Scheme of Utilization of

Services of Retired Teachers (to MAR) and the Faculty Improvement Programme (to BMN).

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