Chapter III

REVIEW OF LITERATURE

Review of literature:

Family Convolvulaceae comprising 56 genera and about 1650 species through out the world, primarily of tropics and subtropics extending in the North and South temperate regions, particularly abundant in tropical America and tropical Asia. Convolvulaceae have been studied taxonomically by Hallier (1893), Ooststroom (1939) and Austin (1973-1991). In India the circumscription of Convolvulaceae has received attention from several authors such as Hooker (1872 –1897), Cooke (1901-1908), Santapau (1947), Nair (1961-1970), Almeida (2001), Kartikeyan and Anand Kumar (1993), Yadav and Sardesai (2002) and Naik (1998). Hooker (1885) reported 15 genera and 159 species of which 4 species are endemic to Maharashtra. Cooke (1958) reported 18 genera and 78 species for the Presidency of Bombay. Singh *et al.* (2001) reported 17 genera and 83 species of Convolvulaceae for Maharashtra State. Besides, there are many other regional floras in which family Convolvulaceae referred only taxonomically.

The Genus *Cuscuta* is separated in to separate family Cuscutaceae on the basis of embryological characters. The more controversial family is the Cuscutaceae, an annual, essentially achlorophyllous, twining parasite. Johri and Tiagi (1952) recognized the family Cuscutaceae on the basis of parasitism, presence of a corona, absence of a parietal cell in the nucellus, mono or bisporic origin of the embryosac, persistent and haustorial nature of one of the synergids, aggressive activity of the endosperm, a suspensor of the coenocytic and vesicular cells or of uninucleate nonvesicular cells, lack of histogenic differentiation in the pre-embryo, a filiform spirally coiled embryo without differentiation in to cotyledons, and an endospermic seed. Embryo chlorophyllous; curved, or coiled, or other than straight, curved, bent or coiled (spiral). The tribe Cuscutaceae has special characteristics, including a parasitic life and spiral embryos without cotyledons. The family Cuscutaceae was separated not only because of its parasitic nature but also because of its distinct embryological features such as undifferentiated filiform embryo and copious endosperm. The separation of family Dichondraceae is on basis of only cleistogamous flowers.

Hallier focused on the surface morphology of pollen grains and classified the family Convolvulaceae in to two subfamilies: a smooth-surface subfamily, or psiloconiae and a spiny-surface subfamily, or echinoconiae. He considered that the latter phylogenetically derived from the former one. Convolvulaceae has been

Govil (1971) reported the zonation in the shoot apex and leaf initiation in the *Ipomoea batatas*, *I. purpurea*, *I. pes-caprae* and *I. quamoclit*. He found that tunica is two layered in all except *I. quamoclit* where it is 3-4 layered. Apical and sub-apical cells differentiate early in ontogeny.

Govil (1971) investigated the organ development in the flower of three species *Ipomoea batatas*, *Ipomoea purpurea* and *Jacquemontia paniculata*. The development is acropetal and is successive in sepals and simultaneous in other organs. The early development is leaf like.

Bhattacharyya (1976) wrote a note on two species of *Ipomoea*, namely *I. carnea* and *I. fistulosa* and these two species were introduced in the gardens of eastern Asia and were growing in the wild area. So they were incorporated in regional floras. These two species are very similar and confused with each other. For distinguish them he studied detailed morphological, ecological and anatomical features. Fruit structure is similar in the same species besides this leaf structure and anatomy distinguishes them easily.

Austin (1977) revised original publications, illustrations, type specimens, distribution and habitat of *Ipomoea carnea* and *Ipomoea fistulosa*. Preferences are reviewed and the criteria are used to separate two names *Ipomoea carnea* and *Ipomoea fistulosa* at the species level were found invalid. So two species are recognized *Ipomoea carnea* and *Ipomoea carnea* spp. *fistulosa* most exclusively.

Keeler (1977) observed *Ipomoea carnea* possesses two types of extrafloral nectaries, located on the petiole and on the pedicel. These secrete complex nectar containing sugars and amino acids. In 1980 author studied *Ipomoea leptophylla* with two types of extrafloral nectaries: foliar nectaries and nectaries on the outside of the sepals. These results are similar to those for *I. carnea.*

Keeler and Kaul (1979) reported the occurrence of petiolar nectaries in 24 species of *Ipomoea*. Petiolar nectaries were found on 12 species including 8 new reports and 4 confirmations of previous reports. Same author in 1984 investigated the structure and distribution of defense nectaries in the genus *Ipomoea* (Convolvulaceae). They show that these nectaries do not reward pollinators and probably contribute to antiherbivore defense.

Keeler (1980) observed two types of extrafloral nectaries i.e. foliar nectaries and nectaries on the outside of the sepals in *Ipomoea leptophylla*, which attract insects

aquatica are more primitive than others. By using different seeds characters they show grouping and interrelationships between the species.

Deroin (1999) gave an interpretation of the gynoecium at various stages of development in family Convolvulaceae in the tribe Ipomoeae. Deroin (2002) reported the floral anatomy of two *Maripa* species.

New genus and species:

Austin and Staples (1980) described *Xenostegia* as new genus with two species *X. tridentata and X. medium.* These two species previously included in to genus *Merremia.* Stigma anatomy, pollen morphology, cotyledon structure and other traits suggest that two species formerly considered members of *Merremia* fall outside an acceptable range of variation for that genus

Robertson (1982) described *Odonellia*, a new genus of Convolvulaceae with two species *O. hirtzfora and O. eriocephala* from Tropical America. These two species previously included in to *Jacquemontia. Odonellia* differs from *Jacquemontia* by having simple rather than stellate trichomes, seeds characters etc.

McDonald (1982) described *Ipomoea expansa* as a new species of *Ipomoea* from Southwestern Mexico. McDonald (1987) described three new species of Convolvulaceae viz. *Merremia austinii, Ipomoea miquihuanensis,* and *I. zimmermanii* from the Northeast Mexico. *Merremia austinii,* named in recognition of the leading authority on New World Convolvulaceae, Dr. Daniel F. Austin. The species exhibit close affinities to *Merremia aurea, M. palmeri, M. platyphylla* and *M. tuberosa. I. zimmermanii* named after the Dr. Alan Zimmerman. Affinities of *I. zimmermanii* are clearly with *I. rupicola* House. *Ipomoea miquihuanensis* named after the locality Miquihuana in forest of large pines.

Eckenwalder (1989) described *Ipomoea praematura* as a new species of *Ipomoea* section Quamoclit from the Caribbean and a new combination for a Mexican species. The species is closely related to *I. hederifolia.* It is distinguished from other members of the *I. coccinea* complex (Eckenwalder and Brown, 1986) by its short sepals.

McDonald and Austin (1990) reported a new species *Ipomoea tabascana*, which is described from Mexico, and the combination *I. batatas* var. *apiculata* is made for plants endemic to Veracruz.

Staples and Austin (1981) discussed two Wets Indian Names in *Operculina* compared with *O. turpethum* and concluded that *O. triquerta* is synonym of *O. turpethum* and *O. ventricosa* is considered a variety of *O. turpethum.*

McPherson (1981) recognized the taxon containing the arborescent species of *Ipomoea*, which are heterogeneous. A reclassification of the group has resulted in a taxon that can be characterized by several features like habit, inflorescence type, sepal size, shape, texture, and pubescence, corolla color and pubescence, and seed pubescence in contrast to its historical antecedent. The relationships of the ten constituent species are briefly discussed with complete descriptions.

Austin and Staples (1991) reviewed the circumscription, taxonomic history, and morphological characteristics of the genus *Turbina.* The Old World taxa of *Turbina* are summarized, in which four species of *Turbina* have been known in the New World; a new species from lower Amazonian Brazil, *T. amazonica was* described.

Austin and Huaman (1996) gave a synopsis of *Ipomoea* in America, in which total of 339 taxa (327 species, five varieties, five subspecies) were recognized, which are placed in infrageneric categories.

Austin (1998) studied genus *Aniseia,* contains three species, *A. argentiana, A. cernua,* and *A. martinicensis* where he included keys, descriptions, and known distributions of the three species from America.

Hsu *et al.* (2006) solved the problem regarding identification of *Ipomoea nil* in Taiwan. The complex includes four species. They neutralized *Ipomoea purpurea* by comparing photographs of *I. hederacea, I. indica, I. nil* including diagnostic keys.

Staples (2007) give a synopsis of *Rivea*, which accounts for all names published in the genus in a concise nomenclatural review.

Palynology:

The first palynological studies in the family Convolvulaceae was made by Hallier (1893). On the basis of pollen morphology he divided family in to two group's viz. 'psiloconiae' and 'echinoconiae.' The pollen grains in the 'psiloconiae' were either psilate or with granulated surface whereas pollen grains in 'echinoconiae' possesses spines. He reported presence of tri-tetra-penta-hexa-panto-colpate and pantoporate grains in the Convolvulaceae.

grains are punctitectate like those in tricolpate type. An illustration of exine pattern for each species is given and key is provided for the identification.

Austin (1973) studied the palynology of the American Erycibeae. In earlier paper he gave interpretation of the systematic relationship of the genera *Maripa, Dicranostyles* and *Lysiostyles.* Pollens are small 3-colpate in *Dicranostyles* and *Lysiostyles* whereas large, zonocolpate or pantocolpate in *Maripa.* Mainly three types of pollen are found which are Dicranostyles Type (A *Dicranostyles*-subtype, B *Kuhlmanniella*- subtype), Lysiostyles Type and Maripa Type (A *Maripa*-subtype, *Melofructae*-subtype, *Yucuascae*-subtype, and Ripama-subtype). He proposed a phylogeny of pantocolpate pollen in *Maripa.* There is correlation between pollen types and corolla shape in *Maripa.* The corollas of *Dicranostyles*-subtype are campanulate and the pollen is distinctive. Corolla of subgroup *Kuhlmanniella* are funnel shaped but the pollen is to that of *Lysiostyles.* Although the corollas of *Lysiostyle* are subrotate, they are much modified and have lobes terminating in long filiform apices. The corollas of both *Lysiostyles* and subgroup *Kuhlmanniella* are highly modified and different; perhaps their pollen similarity is due to parallel evolution. He concluded that basic pollen aperture type for the family is 3-zonocolpate from which pantocolpate type has been derived.

Vij and Sachadeva (1974) worked on pollen grain of 31 species of North Indian Convolvulaceae, the shape of pollen grains varied from prolate-subprolate to prolate spheroidal. The smallest pollens were seen in *Porana paniculata* while the largest in *Ipomoea hederifolia.* The pollen grains were light yellow in the genus *Cressa, Evolvulus, Convolvulus, Merremia, Jacquemontia, Porana, Cuscuta* and *Argyreia.* In *Ipomoea* it ranges from yellow to brown color. Gamble (1923) called these morphotypes as spinulose and non-spinulose, which were later Erdtman (1971) divided pollen morphotypes as 'Ipomoea type' and 'Convolvulus type'. The author agreed with these earlier observations of morphotypes. Taking the shape and length of the spines in to consideration the 'Ipomoea type' grains divided in to five groups.

1. Spines with pointed ends and flat bases (not bulbous).
2. Spines with pointed blunt ends and bulbous bases.
3. Spines with blunt ends and bulbous bases.
4. Spines with oblong shape.
5. Spines with more or less knob like end and bulbous bases.

Cytology:

Wolcott (1937) had determined chromosome number of seven species of the Convolvulaceae among six species that had been counted prior was confirmed again.

Rao (1947) studied chromosome in genus *Ipomoea.* King and Bamford (1927) have published a list of chromosome numbers of several species in *Ipomoea.* Both mitosis and meiosis were studied which shows 2n=30 for *I. carnea, I. pulchella* and *I. reptans.* In *I. batatas* somatic pairing was found among the chromosome in pairs in majority of plates.

Sampathkumar *et al.* (1981) studied somatic number of 43 taxa, including varieties. The chromosome numbers of 11 taxa also been determined in addition to previous work. The chromosomes of this family are small, majority of them ranging between 1.6 microns to 3.8 microns, with a maximum length of 8.6 microns in *Jacquemontia pentantha.* They gave a schematic diagram, which shows possible karyo-phyletic derivation of various chromosome numbers in the Convolvulaceae and Cuscutaceae. He had proposed a system of classification in comparison to Hooker's system of classification and Hallier's system of classification of Convolvulaceae.

Sewane (1986) determined the somatic chromosome number from rot tips of *Ipomoea fistulosa.* The chromosomes of *Ipomoea* spp. are small. Majority of them have average chromosome length between 2.51μ to 3.19μ. The 2n=30 is investigated which confirms the report by Love (1974) and Vij *et al.* (1977).

Sinha and Sharma (1992) give taxonomic significance of karyomorphology in *Ipomoea spp.* They found that the chromosomes are small and appear to be highly variable, ranging from 1.04 to 4.58 μm. They have been classified as long, medium and short ones. The somatic number of all the taxa is 2n=30 except in *I. batatas* where 2n=90. The basic number for the genus is X=15.

Pollination:

Pollination in the family Convolvulaceae is primarily by bees, also there are instances of pollination by moths, birds and bats.

Galetto and Bernardello (2004) studied the floral nectaries, nectar production dynamics and chemical composition of 6 species of *Ipomoea* in relation to pollinators. They concluded that the chemical composition, production dynamics and removal

classification (Austin and Huaman 1996; Austin 1997) nor any other previous subgeneric arrangements of *Ipomoea.*

Manos *et al.* (2001) studied phylogenetic analysis of *Ipomoea*, *Argyreia*, *Stictocardia*, and *Turbina* and suggested a generalized model of morphological evolution in morning glories. They showed the *Ipomoea* is paraphyletic. Phylogenetic analysis of an exemplar sample of *Ipomoea* and related genera strongly support the paraphyly of *Ipomoea.*

Neyland (2001) suggests that *Cuscuta* is a derived member of Convolvulaceae on the basis of analysis of (26S) rDNA sequences. *Cuscuta* is a parasitic angiosperm that has been considered alternatively either as a genus within Convolvulaceae. Extreme reduction of morphological and anatomical characters, as well as chloroplast genome reductions and rearrangements, has made the phylogenetic placement of *Cuscuta* is uncertain. Molecular results are discussed in relation to the morphological and anatomical characters of autotrophic member's of Convolvulaceae. This study also suggests that Solanaceae and Convolvulaceae are sister taxa.

Miller *et al.* (2002) reported monophyly of genus *Ipomoea* and the tribe Argyreieae on the basis of quantitative assessment. Previous systematic studies of morning glories intimated the paraphyly of *Ipomoea* by suggesting that the genera within the tribe Argyreieae are derived from within *Ipomoea.* They applied a Bayesian analysis to provide quantitative estimates of monophyly in an investigation of morning glory relationships using DNA sequence data.

Stefanovic *et al.* (2003) presented a formal reclassification of Convolvulaceae on the basis of molecular studies. The group of spiny-pollen bearing Convolvulaceae (forming "Echinoconiae") and tribe Cuscuteae are retained essentially in their traditional sense, Cresseae are circumscribed with only minor modifications, Convolvuleae and Erycibeae are recognized in a restricted sense, while Dichondreae and Maripeae are expanded. Also, to produce a tribal taxonomy that better reflects phylogenetic relationships, the concept of Poraneae is abandoned as artificial, three new tribes are recognized (Aniseieae, Cardiochlamyeae, and Jacquemontieae), and a new tribal status is proposed for the Malagasy endemic *Humbertia* (Humbertieae).

Stefanovic *et al.* (2005) used PCR approach to obtain large portions of plastid genome sequence from *Cuscuta sandwichiana* in order to determine the size, structure, gene content, and synteny in the plastid genome of this *Cuscuta* species belonging to the poorly investigated holoparasitic subgenus *Grammica.*