Review of Literature

The family Liliaceae (including Amaryllidaceae) as defined by Cronquist (1981) consists of about 280 genera and nearly 4000 species wide spread throughout the world, but most abundant and varied in fairly dry, temperate to subtropical regions. Hutchinson (1958) divided family Liliaceae into 28 tribes and family Amaryllidaceae into 13 tribes. The family is segregated into as many as 21 families which indicates the diversity of the family, but the mutual affinity among all the members is also widely recognised.

Many members of Liliaceae are familiar garden or indoor Ornamentals. They are also known as petaloid monocotyledons. Species of many genera are grown as ornamentals for their beautiful foliage and flowers. Allium and Asparagus species are cultivated for food, and bulbs of Camassia were a favourite food of Western Amerindians (Cronquist, 1981). Many lilies are highly poisonous. Zigadenus has the appropriate common name of death camas and Veratum has been identified as the cause of a congential deforming in lamb. The red squill, used in rodent control measures is from the bulbs of Urginea (Lawrence 1951). Aloe, Urginea, Asparagus and many other species have medicinal value. Colchicum is extracted from Colchicum autumnale L. (Hutchinson, 1958)

...8...

Family Liliaceae has fairly good economic importance.

Among monocotyledons family Liliaceae is found to be very ideal for cytological and embryological studies because of their large nuclei, chromosomes and the ease with which the materials takes the usual cytological stains. It forms classifical material for cytological studies and class room work. The family is well studied cytologically (Taylor, 1925; Newton, 1927; Raghavan, 1935; Sato, 1942; Therman, 1951; Wet, 1957; Maugini, 1960; Neves, 1962; Pienaar, 1963; Battaglia, 1964; Jones, 1967; Oyewole,1971; Jessep, 1972, 1977; Zakharyewa and Makushenko, 1969; Fluellen, 1974, 1975, 1984; Septa and Greilhuber, 1977; Jha and Sen, 1973, 1974, 1976,1980 a, 1982, 1983, 1983 a,b; Vosa, 1980; Rao and Mwasumbi, 1981; Septa, Greilhuber and Deumling, 1981; Stedje, 1982; Knudtzou, 1983; Alfsen, 1984; Stedje and Nordal, 1985; Knudtzou and stedje, 1986; Jenkins and White, 1988; Whitean and Jenkins, 1988; Dixit and Yadav, 1989; Yadav and Dixit, 1990;). A critical review on the importance of the order Liliflorae from Phylogenetic point of view has been discussed by Mitra (1955).

Good amount of embryological work has been done on the members of Liliaceae. Schnarf (1931) have reviewed the embryological literature on this family upto the year 1930.

...9...

After that Eunus (1950) has given full review of embryological work in family Liliaceae. Fairly good amount of embryological work has been done in Liliaceae which is reviewed again by Davis (1966). In family Liliaceae sub-family Scilloideae has been receiving keen attention both from embryological and taxonomic point of view (Wunderlich, 1937; Caves, 1953; Svoma, 1981; Ebert, Svoma and Septa, 1983; Svoma and Greilhuber, 1984, 1987, 1989). Family Liliaceae is of special interest as the development of the embryo sac shows a considerable range of variation. As many as 5 distinct types of embryo sacs have been recorded in the family. There have been little work on Palynology of the family. There are some studies with light microscopy (Nair and Sharma, 1965; Radulescu, 1972, 1973 b, 1973 c, 1973 d) and with electron microscopy (Zavada, 1983).

Tribe Scilleae as defined by Hutchinson consists of about 25 genera and most of the genera are found in Africa. It is more or less equivalent to sub-family Scilloideae or family Hyacinthaceae. The group is characterized by tunicated bulbs, flowers in racemes, capsular fruits and seed globose, angular or compressed. This group has been a centre of interest of many workers

...10...

(Wet, 1957; Stedje and Nordal, 1987). Most of the genera have received considerable attention by workers.

For understanding of evolution, cytology and embryology of genus Scilla has been studied extensively (Morinaga, 1932; Sato, 1935; Wunderlich, 1937; Raghavan and Venkatasubhan, 1939; Sheriff and Murthy, 1946; Simon, 1951; Battaglia, 1952, 1957, 1963, 1964 a; Sunder Rao 1954, 1956; Haga and Noda, 1958, 1976; Gimenez - Martin, 1959 a,b,c; Noda, 1961, 1967; Meikle, 1967; Toren, 1968; Jossep, 1970; Akari, 1971, 1972; Mordak, 1971; Baumann, 1971; Vosa, 1973; Septa, 1974; Takahashi, 1976; Greilhuber and Septa 1976, 1978; Greilhuber, 1977; Deumling, 1978; Araki, Uchino and Jinno, 1979; Svoma, 1981; Sheriff and Rao, 1981; Deumling and Greilhuber, 1982; Hong de Yuan, 1982; Kereszty and Szilagyi 1983; Uchino and Tanaka, 1988; Jenkins and White, 1988; Dixit et al., 1989).

Urginea is a another genus whose cytology has been studied extensively. (Maheshwari, 1932; Sato, 1934,1942; Raghavan, 1935; Raghavan and Venkatasubban, 1940 a,b; Capoor, 1937; Martinoli, 1949; Garmela, 1950; Kishore, 1951; Maugini, 1953, 1956, 1960; de Wet, 1957; Neves, 1958; Battaglia, 1957 a, 1957 b, 1957 c, 1958, 1964; Miege, 1960; Ayyangar, 1962, 1964 a-b, 1965, 1966, 1969; Datta, 1966; Love, 1964;

...11...

Subramaniam, 1972; Battaglia and Guanti, 1968; Moorthi and Sampathkumar, 1968; Maugini and Maleci, 1974; Sen, 1974; Oywole, 1975; Kamble and Ansari, 1976; Naik, 1976; Zaman and Khaleque, 1978; Jha and Sen, 1980; Patil, 1981, 1984; Nwankit, 1983; Dixit and Yadav, 1989; Dixit and Yadav, 1990).Embryology of U.indica, U. polyantha and U. razii has been worked out (Maheshwari, 1932; Capoor, 1937; Patil, 1988).

Another genera such as Albuca, Bowiea, Drimia, Drimiopsis Ornithogalum have received less attention. (Leighton, 1945; Therman, 1951; Lima de Faria, 1958; Neves, 1962, Chiappini, 1962; Fernandes and Neves, 1962; Nordenstam, 1969; Oyewole, 1971; Jossop, 1972; Fluellen, 1974; Vosa, 1980; Stedje and Piennar, 1982; John, Alfsen and Sen, 1984; Knudtzon and Stedje, 1986; Stedje and Nordal, 1987).

Genus Dipcadi which belong to sub-family Scilloideae has received little attention. Out of about 50 species only few species have been studied cytologically and embryologically. The genus Dipcadi belonging to sub-family Scilloideae was postulated by Medikus.in Acta Acad. Theod. Palat.6:431 in 1790,on the basis of the Hyacinthus serotinus L. collected from spain. Medikus (1790) distinguished genus Dipcadi from Hyacinthus L. on the basis of tubular, erect perianth lobes and numerous flat seeds. Ker-Gawler (1816) described the

...12...

genus Uropetalum on the basis of sixfid tubular perianth lobes subduplicate to the tube, and numerous flat seeds. Edgeworth (1846), Dalzel (1850) and Stocks (1852) subsequently added some species to this genus from Indian subcontinent.

Reichenbach (1828), Endlicher (1836), Lindley (1836) and Kunth (1843) did not recognise the genus Dipcadi. Baker (1871) however, revived Dipcadi Medik and relegated Uropetalum Ker-Gawl to synonymy of the Dipcadi. In his monographic studies Baker (1871) subdivided bulbous Liliaceae with raceme inflorescence into two groups, gamophyllous Hyacintheae and Polyphyllous Scilleae and placed Dipcadi Medik in Hyacintheae.

Bentham (1883) did not lay any importance on such distinction and merged Hyacintheae in Scilleae, thereby placing Dipcadi Medik in Scilleae. Subsequent workers followed Bentham (1883) in keeping all the genera under a single group without subdividing the tribe Scilleae.Engler and Prantle (1930) raised tribe Scilleae to the rank of a sub family in the name of Scilloideae. Hutchinson (1958) on the other hand did not recognise the family and placed the genus along with 24 other into tribe Scilleae. In recent classification family Liliaceae is divided into as many as 21 family and genus Dipcadi is placed in family Hyacinthaceae.

...13...

Genus Dipcadi Medik. is represent by about 55 species distributed in Africa, Madagascar, Socotra, Mediterranean region and India (Willis, 1973), however, according to Dyer (1976) there are about 30 species in the genus. The genus has African and Asiatic distribution, however, there is one species D. serotinum (L.)Medik. which inhabits the South West of Europe viz. Portugal, Spain, South France, Italy (Tutine et al. 1980).

Cytogeographical studies of Hyacintheae in Africa South of Sahara by Stedje and Nordal (1987) have revealed that Southern Africa is probably a centre of dispersal (and origin?) for genera such as Albuca, Dipcadi, Drimia, Urginea and Drimiopsis. Nersveen (1980) has made revesion of Dipcadi Medik. species of tropical Africa.

In India, the species of the Dipcadi are mostly distributed in hills of arid region, also in dry stream beds and marshy places, in scrub jungles, in crevices of rocks and forest floor. Various species show significant morphological variations in different populations of same species growing at different localities. J.D. Hooker (1892) reported 6 species of Dipcadi from British India. T. Cooke (1907) in his flora of the precidency of Bombay reported 4 species of the genus. During revision of flora of Bombay

...14...

Precidency, Blatter and MaCann (1928) described two new species of the genus viz. D. ursulae Blatt. and D. saxorum Blatt. both of them restricted to Maharashtra. In the course of a taxonomic study of the genus, Deb and Dasgupta (1975) described two new species viz. D. maharashtrensis, D. reidii and variety of D. ursulalae Blatt. named D. ursulae Blatt. variety longiracemosae. A taxonomic revision of the genus Dipcadi in India and adjoining regions reports 9 species and two varieties. Dipcadi hydsuricum (Edgew) Baker is relegated to synonymy of D. serotinum (L.) Medik. and D. unicolor (Stocks) Baker to D. erythraeum Webb. and Berth and D. madrasicum Fischer and Barnes is reduced to a variety of D. montanum (Dalz.) Baker.

In recent revesion on tribe Scilleae, Deb and Dasgupta (1981) reported 9 species and two varieties of genus Dipcadi from India viz. D.concanense (Dalz.) Baker, D. erythraeum Webb. et. Berth, D. maharashtrensis Deb and Dasgupta, D.minor Hook.f, D.montanum (Dalz.) Variety montanum and D.montanum variety madrasicum (Burnes et. Fischer) Deb and Dasgupta, D. reidii Deb and Dasgupta, D. saxorum Blatt. D.serotinum (L.) Medik, D.ursulae Blatt. Variety ursulae and D.ursulae Blatt. variety longiracemosae Deb and Dasgupta. Out of total number of species reported for India, 3 are endemic to India. They

...15...

are D.concanense, D. saxorum and D.ursulae. Interestingly they are only found in Maharashtra and restricted to small areas. Mistry and Almeida (1989) reports that D.concanense as a rare and threatened endemic plant species of Ratnagiri District. Similarly so far D. saxorum, an endemic species is known only from its type locality viz. Kaneri caves and is equally rare and is in endangered state (Personal observation).

The genus Dipcadi is less studied cytologically. Out of 50 species, cytology of only 10 species have been worked out viz D. serotinum (Sato, 1942, Levan, 1944, Resende and Franaca 1946, Fernandes et al. 1948, Gadella, 1966,Vaides, 1970, Fernandes and Queiros, 1971, Love and Kjellquist,1973, Ruiz Region, 1974, 1978, Darlington and Janaki Ammal, 1945), D. glaucum (Darlington and Wylie, 1955; Darlington and Janaki Ammal, 1945), D.fulvum (Battaglia, 1954), D.montanum (Mahabale and Chennaveeraiah 1954, 1962, Naik 1974, 1983), D.saxorum (Mahabale and Chennaveeraiah 1954, 1962, Naik 1974) D.marlothii (Fernandes and Neves 1962, de Wet, 1957, Ratter and Milne 1973) D.longifolium (Rao and Mwasumbi, 1981, Stedje and Nordal, 1987), D.concanense (Kanmani 1975, Dixit et al. 1990). The chromosomes numbers reported in different species with their authors is summarized in Table-1.

...16...

TABLE NO.1

SHOWING CHROMOSOME NUMBERS REPORTED IN DIFFERENT SPECIES OF DIPCADI MEDIK.

Name of species	Chromosome No.	Authors name
1. D.concanense (Dalz) Baker.	n=6	Kanmani 1975 Dixit et al. 1990.
2. D. fulvum	n=17	Battaglia 1954
3. D. glaucum	n=4	Darlington and Janaki Ammal,1945
	n=9	Darlington and Wylie 1955
4. D.longifolium Bak.	n=6	Rao and Mwasumbi,1981 Stedje and Nordal,1987
5. D. marlothii Engl.	n=6	deWet 1957 Fernandes and Neves,1962
	n=3	Ratter and Milne,1973
6. D.montanum Bak.	n=10,6	Naik 1974, 1983
	n=10	Mahabale and Chennaveeraiah, 1954,1962.
7. D.saxorum Blatt.	n=6	Mahabale and Chennaveeraiah, 1954, 1962, Naik, 1974.
8. D.serotinum (L.)	n=4 Octaploid	Sato, 1942, Levan,1944, Borgen, 1974
	2n=4+2-16B	Resende and Franaca,1946
	2n=8+0-1B	Fernandes, 1948
	2n=8+0-16B	Gadella, 1966
		Vaides, 1970
		Fernandes and Querros,1971
		Love and Kjellquist, 1973
		Ruiz Region, 1974, 1978
	n=4	Darlington and Janaki Ammal,1945.

... 17...

Name of specids	Chromosome No.	Authors name
9. D.viride (L.)	n=6	deWet 1957 Fernandes and Neves, 1962 Stedje and Nordal, 1987
10. D.ursulae Blatt.	n=10	Mahabale and Chennaveeraiah, 1954,1962 Naik, 1983

Studies on the geographical distribution of different karyotypes of Tropical African genera of Hyacinthaceae viz. Albuca, Dipcadi, Drimia (including Urginea) and Drimiopsis have shown a general trend of increasing level of ploidy and/ or basic number and a tendency of increasing karyotype asymmetry from the South towards north and west which suggests that the South Africa is probably a centre of dispersal (or Origin ?) for these genera (Stedje and Nordal, 1987). Varied number of B chromosome are reported in single species viz. D.serotinum (L.) Medic. Although the numbers reported for this species are confused to some extent (2n = 8,16,32,64) however, most of the populations show 2n = 8. Variable number of B chromosomes is reported in the species by Resende and Franca (1946), Fernandes et al. (1948) Gadella et al. (1966), Valdes (1970), Fernandes and Queiros (1971), Love and Kjellquist (1973), Ruiz (1974,1978), Valdes et al. (1978), Ruiz et al. (1980)

The basic number for the genus Dipcadi is considered to be x = 4 (Naik, 1974). However, the lowest chromosomes number is reported from Natal 2n = 6 for D. marlothii Eng. (Ratter and Milne, 1973). The occurence of D.serotinum (2n = 8) in the Mediterranean region is considered as a link between Africa and India with basic karyotype (2 VL + 4 L + 2 S + 2 VS) for the genus Dipcadi (Naik, 1974). According

...19...

to Dixit et al. (1990) karyotype of D.serotinum may be explained by an increasing asymmetry leading to final loss of short chromosomes in the same fashion as proposed for Ornithogalum (Stedje and Nordal, 1987) and basic karyotype may have 2 VL + 1 M pair as observed in D.marlothii (2n = 6) (Ratter and Milne 1973).

Cytology of 4 Indian species has been worked out so far. The species include D. concanense with n=6 and 2n=12 (Kanmani, 1975, Dixit et al. 1990), D.montanum with n=10 and 2n = 20 (Mahabale and Chennaveeraiah 1954, 1962) and with 2n = 10 and 12 (Naik, 1974, 1983), D. saxorum with n = 6 and 2n = 12 (Mahabale and Chennaveeraiah 1954, 1962, Naik, 1974) and D. ursulae with 2n = 20 (Mahabale and Chennaveeraiah,1954, 1962 and Naik, 1983).

Development of embryo sac in Liliaceae is of special interest which shows a considerable range of variations. As many as 5 types of embryo sac development have been recorded. Although majority of genera show polygonum type of embryo sac, Allium type have been recorded in genus Scilla (Hoare, 1934) and Convallaria (Stenar, 1941) Drusa type in Majanthemum (Stenar - 1934), Fritillaria type in Fritillaria (Bambacioni, 1928) and this type of embryo sac is characteristic of subfamily Lilioideae and Adoxa type in genus Erythronium.

...20...

Recently taxonomic importance of embryological character and their evolution in Scilla species have been throughly studied by Erika and Greihuber (1988, 1989).

Cytological as well as embryological studies have been made on Dipcadi by Schnarf (1931), Eunus (1950), Cave (1953), Wunderlich (1937), Buchner (1948), Chennaveeraiah and Mahabale (1959, 1962). Their studies revealed that there a normal Polygonum type of embryo sac in Dipcadi species which they have studied. Chennaveeraiah and Mahabale(1959) described the sporogensis in D.serotinum. They also found that all eight chromosomes in this species have satellites which take part in nuclear organisation. In this species meiosis is highly irregular in megasporogensis and microsporogensis and there is Polyspory which suggests hybrid origin of the species. Studies on cytoembrylogy of D.montanum revealed that the species have anther development of monocot type, polygonum type of embryo sac, caryophyllad type of embryo development and Helobial type of endosperm development.

Obermeyer (1964) redescribed south african species of Dipcadi with keys to the species. He also gave economic importance of 7 species of the genus. The bulbs of the some species of the genus are used as food during scarity

...21...

of food. In India bulbs of D.erythreaum are eaten in Sind, Baluchistan and Rajasthan (Deb and Dasgupta, 1981 and personal inquiry with local people of Rajasthan). Similarly bulbs of D. montanum variety madrasicum are edible and eaten at the time of scarity of food. Dipcadi concanense has 4-5 cm. long pure shining white flower. Possibility of exploting it for ornamental purpose is indicated by Dixit et al. (1990).

Thus the genus is of little economic importance but definitely of botanical interest in understanding centre of dispersal, Origin and evolution of Hyacinthaceae in general (Stedje and Nordal 1987) and Origin, dipersal and evolution of the species of Dipcadi in perticular (Naik 1974, 1983, Stedje and Nordal, 1987).

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