Discussions

Genus Dipcadi, Medik distributed in Africa, Madagascar Socotra, Mediterranean region, India is represented by about 55 species (Willis, 1973), however, according to Dyer (1976) there are only 30 species of the genus. The difference in species number is probably due to characters used in identification of species. The identification of species is mostly based on characters taxonomically considered to be bad characters. Although genus Dipcadi is of little economic importance, it is interesting from botanical point of view in understanding evolution and diversification of Scilleae in general and Dipcadi in particular. The critical studies on morphology, cytology and anatomy of Dipcadi species growing in Maharashtra have revealed some important results which are discussed below.

(A) Morphology - J.D. Hooker (1892) reported 6 species of the genus Dipcadi for British India. At present according to Deb and Dasgupta (1981) there are 9 species and two varities in the country. Out of 9 species occuring in India, three are considered to be endemic to the country.

Most of the Indian species are found in Mahrashtra. Cooke (1907) in his flora of the precidency of Bombay reported 4 species of the genus namely D. concanense, D. montanum, D. minor and D. erythraeum. D. erythraeum is

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restricted to Gujarat and Rajashtan area. Thus Cooke reported only three species of Dipcadi from present teritory of Maharashtra.

During revesion of flora of Bombay precidency, Blatter and Macann (1928) described two new species viz. D. ursulae and D. saxorum for the state. In the course of study of the genus for revised flora of India under the ouspices of Botanical Survey of India, Deb and Dasgupta (1974) described D. maharashtrensis and variety of D. ursulae viz. D. ursulae var. longiracemosae from Maharashtra. In recent taxonomic revision of Dipcadi Deb and Dasgupta reported 9 species and two varieties of Dipcadi from India. Out of 9 species 5 species occur in Maharashtra and all the three species viz. D. concanense, D. saxorum and D. ursulae considered to be endemic to India are restricted to Maharashtra. D. maharashtrensis is also recently described from Maharashtra. Thus it seems that the western ghats of Maharashtra is major centre of diversification for the genus in India.

The species reported for Maharashtra are mostly based on herbarium specimens. No efforts have been made to study the variations in different populations of same species. Secondally there are no good characters for delimitting the species. Even the most recent taxonomic treatment (Deb and Dasgupta, 1981) is based mainly on

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features such as leaf length and breadth, length of scape, flowers per scape, length and nature of bract, pedicel nature etc. Moreover these characters are affected by precipitation, soil condition and other climatic factors. Therefore recognition of certain species is doubtful.

Study on morphology of different species of Dipcadi in field and under pot and plot culture (improved conditions) have shown that under cultivation there is significant increase in quantitative characters of every species except D. concanense (Text fig. I, figs. 1-7). Populations collected from Mahableshwar, Kas, Panhala, Kartikiswami grown in earthern pots and plots showed great increase in quantitative characters. Even after careful observation on living plants it was difficult to distinguish between D. montanum, D. ursulae and D.maharashtrensis. The populations from above localities showed entire range of variations in quantitative characters from D. montanum to D. ursulae to D. maharashtrensis. It is true that some plants in populations from Kas and Panchagani plateau have coriaceous bracts but they are not true breeding. In preliminary work on hybridization it has been observed that D. maharashtrensis easily crosses with D. ursulae and D. montanum and produces viable seeds. Similarly the plants growing in good accumulated soil condition at Kas (in natural habitat) showed luxurient growth and according

to keys given in different Floras fits in D. ursulae at the same time plants growing in vicinity of above plants on laterite in shallow poor soil and more xeric condition fit into D. montanum. Some of the plants showed leaf breadth upto 2.5 cm which is not given in any Flora for any Indian species. The bract length which is used for identification of species is also very variable. In population from Kas and Mahableshwar, some plants showed bract length upto 4 to 5 cm which is double the length given for the Indian species having maximum bract length (D. ursulae and D. maharashtrensis). The populations from Panchgani, Kas, Panhala and Kartikiswami when grown in earthern pots and plots it was very difficult to distinguish these species as plants exhibited entire range of characters from D. montanum to D. ursulae. Therefore the author is of the opinion that the population growing on plateaus of Sahyadri in Maharashtra represent single species viz. D. montanum while D. ursulae and D. maharashtrensis are simply ecological varients of the former species. Thus detailed observation on morphology in field and pot/plot cultured plants have revealed that D. montanum shows great plasticity and ecological amplitude. The characters such as filiform and stout pedicel, coriaceous and scariaceous bracts, flowers per scape and size of scape as well as flower are of no use in distinguishing species as done by Blatter

and MaCann (1928), Deb and Dasgupta (1974 and 1981). Deb and Dasgupta distinguished D. maharashtrensis from D. ursulae on the basis of coriaceous bract and length of bract. Moreover their species is based on single herbarium specimen (Rukmini Bai BR-933) which is without fruit. Our experiments have shown that it easily crosses with D. montanum and D. ursulae. Present author even does not recognise D. ursulae. Thus D. ursulae, D. maharashtrensis and D. montanum are one and same species viz. D. montanum. D. concanense is very distinct species with very long shining white flowers restricted to Konkan area. It's corolla is a conspicuous character and could be easily distinguished from any other species of Dipcadi in India. It is endemic and restricted to Konkan area of Maharashtra. It is restricted in distribution and becoming rare. Mistry and Almeida (1989) reported that D. concanense as rare and threathened endemic plant species of Ratnagiri district. According to Dixit et al. (1990) the greatest diversity in morphological features and distribution pattern of D. concanense suggests rather distinct line of evolution. It has longest shining pure white corolla which is very distinct from all other Indian species and they further suggested its possibility of exploiting for ornamental purpose. Introduction of the species into home gardens as ornamental plant seems to be best measure for the conservation of the species.

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Another interesting species, D. saxorum is also endemic species restricted to Maharashtra. So far it is known only from type locality viz. Kaneri caves near Borivali. It is restricted to very small area and there is threat for its survival due to human activities at Kanheri caves whichis pick-nick place for Bombay tourists. Therefore, there is need for its conservation. The species is distinct in its morphological characters and very easily distinguished by its very small bracts. It shows considerable increase in quantitative characters under cultivation.

(B) Cytology :

Chromosome numbers reported in present investigation of Dipcadi concanense, D. saxorum, D. ursulae and D. montanum agree with previous reports made by Kanmani (1975), Dixit et al. (1990), Mahabale and Chennaveeraiah (1962, 1965), Naik (1974) and Naik and Nirgude (1983). It also confirms the chromosome number 2n = 20 for D. montanum as reported by Mahabale and Chennaveeraiah (1954). However, it differs from the earlier report of n=6 and 2n = 12 chromosomes for D. montanum made by Naik and Nirgude (1983).

It is evident from Table-11 and Plate - V figs. 1-8 that Karyotypes of D. concanense, D. saxorum and D.montanum

are representing specific differentiations. Karyotypes in all the species studied are of bimodal type and indicating advanced nature of the taxa. Differences in absolute chromosome size reflects different amounts of gene duplications either in tandom fashion or through polytene multiplication of chromonemata and also that species having greater chromatin length were supposed to be primitive where as species with lesser chromatin length were treated as advanced (Stebbins, 1971). The data on haploid chromatin length (Table 12) show that the chromatin length is minimum in D. saxorum followed by D. concanense and ranging between 23-89 - 27.21 mu both being diploids with 2n = 12, while in D. montanum (2n=20) with its various morphs (narrow leaved form, D.ursulae , D. ursulae with broad leaves and coriaceous bracts, D. maharashtrensis a form with coriaceous bracts) it ranges from 38.04 to 48.21 mu and thus implies ploidy effect in the process of speciation. Wider range of TCL %, higher TF % and 5% also are of indicative that speciation has taken place through hybridization, polyploidy and loss of chromosomes in the same fashion as proposed for Ornithogalum (Stedje and Nordal, 1987). The haploid compliment length of chromatin reported in D. saxorum by Naik (1971) is in agreement with the observations made in the present investigation. However he has reported in

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case of D. montanum (2n=12) that all chromosomes are acrocentric with 17.8 mu total haploid chromatin length. In present investigation it was observed that in D.montanum somatic chromosome number is 2n=20 with haploid chromatin length ranging from 38.04 - 48.21 mu and this may be suggestive of the allopolyploidic nature of the species. The wide distribution of the species, D. montanum throughout India may be attributed to the presence of such cytological variations with morphological forms.

At lower taxonomic levels the few ill defined morphological traits and plasticity have prevented a satisfactory systematic differentiation until recently in Dipcadi species perticularly in D. montanum. Deb and Dasgupta (1981) in their taxonomic revision of genus Dipcadi mainly used an attributes of quantitative nature such as leaf length and breadth, length of scape, number of flowers in a raceme and their size, relative lengths of bracts and pedicels etc. and which possed intrinsic taxonomic problems in recognising D. montanum. Because in nature its spectrum of variation was so large that these distinction between morphs lead to a different status of the taxa under study (viz. D. ursulae and its varieties and D. maharashtrensis). No doubt that most of the species of Dipcadi sprout out by the begining of monsoon and complete their life cycle within about two

months. Growth and development of the short lived aerial-shoot appears to be largly controlled by time and amount of precipitation together with dry spell between the two. Showers (Naik and Nirgude 1983). This obviously leads to variable growth patterns which makes delimitation of various taxa, found only on the exomorphic features difficult. In this context detailed karyotypic analysis of various morphs of D. montanum (narrow leaved form, D. ursulae, D. maharashtrensis) is found helpful to ascertain the differences between them at chromosomal level. It is rev-ealed from Table 12 that Karyotype of morphs of D. montanum collected from various localities show similar pattern and confer clear morphological variant status to taxa under study. However, minor alteraion in karyotype at intraspecific level (Table-11) is a clear index of structural alterations in chromosomes in the process of evolution of a species. An analysis of relative chromosome size is vital to the understanding of cytological affinities between various forms and species of a genus and various genera of the family. It is clear from the table 11 and 12 that there are significant difference in three species of Dipcadi under study. However, chromosome numbers 1,2 and 3 of all the species under study have shown similar relative chromosome size,

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while chromosome 4 and 5 are of distinct nature in all the species. Chromosome 6 of D. concanense and D. saxorum are of same value, whereas chromosomes 6-10 in different morphs of D. montanum (D. ursulae, broad leaf form and D. maharashtrensis) are of similar value. Thus it is clear from this data that D. concanense, D. saxorum, D. montanum, D. ursulae and D. maharashtrensis have a common genome of first 3 chromosomes, while remaining chromosomes are attributing species specific characteristics. It is also evident from the table 11 and 12 that D.montanum narrow leaved form of D. montanum, D. ursulae and form with large bulb, broad leaves and long coriaceous bracts, and D. maharashtrensis (form with coriaceous bracts) in present investigation are nothing but morphological variants. This indicates to the platicity of the species acquired in varying ecogeographical conditions.

The basic number for the genus Dipcadi is considered to be x = 4 (Naik, 1974). However, the lowest chromosome 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 (2VL + 4L + 2S + 2VS) for the genus Dipcadi (Naik, 1974). However, this Karyotype of D. serotinum

may be explained by an increasing asymmetry leading to a final loss of short chromosomes in the same fashion as proposed for Ornithogalum (Stedje and Nordal, 1987) and basic karyotype may have 2 VL + 1M pair as observed in D. marlothii (2n = 6) (Ratter and Milne, 1978).

Considering the above view of basic Karyotype, chromosome number and data from present study, it is clear that D. concanense, D. saxorum, D. montanum (including D. ursulae with its forms and D. maharashtrensis) are affected by p oidy, hybridization and structural rearrangements in the genome.

It is revealed from present studies that meiotic behaviour in all the species of Dipcadi is associated with some unusual events. In D. concanense and D.saxorum the percentages of meiotic irregularities are comparatively less than in D. montanum (including D. ursulae, D. maharashtrensis). This further implies that D.concanense and D. saxorum are diploids while D. montanum (including D. ursulae and D. maharashtrensis) an allopolyploid in origin. Such kind of allopolyploidic nature is reported in D. ursulae (2n = 20) by Naik and Nirgude (1983) It is also reported by them that the nature of meiotic abnormalities in D. montanum (2n=12) is not clearly understood.

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Levan (1944) indicated a fairly high percentage of failure of metaphase pairing in PMCS of Dipcadi serotinum. Chennaveeraiah and Mahabale (1959) had detected the microsporogensis (univalents, polyspory) and in the megasporogenesis (abnormal megaspore tetrads, extra spindles etc.) of D. serotinum and pointed out its hybrid nature. Ruiz et al. (1981) had attributed these irregularities to the phenomena of gene duplication. Further it is supported by electrophoretic analysis of isoenzyme variability in natural population of this species where two ADH loci and two esterase loci were found duplicated (Pascual et al. 1980, 1981).

In Diplotene and diakinesis of Dipcadi concanense and D. saxorum, it was found that only one nucleolus present and associated with a variable number of bivalents (Plate VI fig. 1-15, Plate VII, Text fig. 1-12). D.montanum (Plate-VIII figs. 6-9) and D. ursulae with large bulbs, broad leaves and coriaceous bracts (Plate VIII Fig. 1-5) presence of 2 nucleoli has shown association of variable number of bivalents. Thus the phenomenon in general indicates that a process of conservation of adaptive gene complexes is working in D. concanense and D. saxorum while in D. montanum (including D. ursulae and D.maharashtrensis) phenomenon of allopolyploidy and re-organisation of genome by structural alternation is in progress.

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From the foregoing account it is clear that not only cytological investigations of large number of species is sufficient to trace the evolution of this genus, but breeding behaviour, banding pattern of chromosomes and studies at molecular level are equally important and helpful in resolving the problem more meaningfully. Further work on hybridization in Dipcadi species occuring in Maharashtra is in progress.

(C) Anatomy :

All the species and forms of Dipcadi growing in Maharashtra have unbranched cylindrical scapes. The length and basal diameter of scape varied in different species. However, no significant differences in anatomical characters of scape,(Text fig. II figs. 1-3, Text fig.III figs. 1-4,),pedicel(Text fig IV, figs 1-3, Text fig.V, figs 1-4), leaf(Text fig. VI, figs. 1-7)and cuticule (Text fig VII, figs. 1-7) were observed.The anatomy of these organs is of little value in distinguishing the species.

The epidermis of scape is single layered made-up of vertically elongated cells. The continuity of epidermis is broken by presence of stomata. The epidermis is covered by cuticle. Epidermis is followed by hypodermis. Hypodermis is made-up of radially elongated cells containing chloroplasts.

It forms palisade like layer below epidermis. Hypodermis is followed by outer cortex made up of 5 to 8 layers of parenchyma. The outermost 1-2 layers are made up of small parenchymatous cells containing chloroplasts while inner layers are made up of large parenchymatous cells enclosing intercellular spaces. Some cells of inner most layers contain starch grains. The inner cortex is made up of polygonal sclerenchymatous cells. Small vascular bundles are found associated with sclerenchymatous cortex. Sclerenchymatous cortex is followed by ground parenchyma. Ground parenchyma is made up of large oval cells enclosing intercellular spaces. Vascular bundles are found scattered in ground parenchyma. Each vascular bundle is conjoint, collateral and closed type. The vascular bundle are radially elongated except in D. saxorum where they are oval in shape. Total number of vascular bundles varied in different species. Kamble and Ansari (1977) gave a brief account of scape anatomy of four species of Urginea and indicated its importance in identification of species. Patil (1988) studied the scape anatomy of all Indian species of Urginea and found that scape anatomy is useful not only in identification of species but also to decide inter-relationship among the species. However, it is revealed from the present studies that scape anatomy is of little or no importance in identification of Dipcadi species.

Studies on pedicel anatomy revealed that the gross anatomical characters remain same in all the species studied. (Text fig. IV figs. 1-3, Text figs.V, figs. 1-4). Transection of pedicel shows single layered epidermis made-up of rectangular to cubical cells. It is covered by very thick cuticle. Stomata are found in epidermis. Epidermis is followed by ground parenchyma. The outermost 2-3 layers are made up of small parenchymatous cells containing chloroplasts. The inner 3-4 layers are made up of large parenchymatous cells with or without starch grains. Vascular bundles are arranged in approximately two circles. The outer small vascular bundles range in number from 9-12 while there are 5-6 large vascular bundles inner to smaller bundles. Deb and Dasgupta (1981) placed D. montanum, D. serotinum, and D. erythraeum under pedicel filiform category and D. saxorum, D. maharashtrensis and D. ursulae under pedicel stout category. However, no anatomical differences in pedicels of various species under study were observed and hence this character seems to be inpracticable in distinguishing species of Dipcadi.

Length and breadthalong with scape length and number of flowers per inflorescence have been used to distinguish some species of Dipcadi. Gross leaf anatomy remains same in all the species of Dipcadi under study. The leaves are isobilateral and amphistomatic. Both upper

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and lower epidermis is single layered made-up of elongated cells. The epidermis is covered by cuticle. Epidermis is followed by single layer of palisade on both surfaces. Distinct stomatal chamber is found below each stoma. Palisade is followed by 3-4 layers of small chlorenchymatous cells. The middle portion of leaf is made up of large parenchymatous cells with intercellular spaces. Vascular bundles are arranged in row in central water storage tissue.

Different species showed few anatomical differences such as presence or absence of raphids, thickness of leaf, number of vascular bundles per leaf and presence or absence of air chambers. Cuticular characters like stomatal density, stomatal index and size of stomata and epidermal cells varied in different species but no marked differences were observed. Thus leaf anatomy and cuticular characters were found to be of little importance.

Although anatomical characters of scape and leaf were found to be useful in taxonomy of Urginea (Kamble and Ansari, 1977, Patil B.R. 1988) and Chlorophyton (Naik and Nirgude, 1981) species, it was found to be of little taxonomic value in Dipcadi species.

(E) Floral anatomy :

Studies on floral anatomy of different species of

Dipcadi found in Maharashtra revealed that the floral anatomy is simple and the course of vasculature to flower remains similar in all the species investigated except variation in number of vascular traces to perianth lobe due to splitting of lateral bundles. (Text figs. VIII to XIV.).

Pedicel of flower usually consists of 6 main vascular bundles arranged in two rings, each with three bundles. The central bundles are large. Many times central bundles are surrounded by 6 to 9 small vascular bundles. However in D. montanum, Mahabale and Chennaveeraiah (1962) reports only 6 bundles per pedicel.

All the vascular bundle form a plexus of vascular tissue immediately below thalamus. This plexus gives out 6 vascular bundles supplying to perianth whorl and stamens. The vascular traces corresponding to small outer bundles of a ring supply to inner perianth lobe and its stamen, while the traces corresponding to large central vascular bundles of inner ring supply to outer perianth lobe and its stamen. Out of 6 traces, each trace divides into three traces. Out of these three traces, the middle bundle divides vertically forming outer bundle which becomes median bundle of perianth lobe and an inner trace which supply to stamen. The lateral traces divide

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further and thus perianth becomes 5-12 nerved. In Dipcadi saxorum the outer perianth lobe has usually 5 bundles and inner with three bundles. In other species the number of traces range from 5 to 12.

When perianth separates from gynoecium the stipe of ovary just above thalamus consists of 6 vascular traces arranged in approximetely single ring. The larger bundles travel outwards and form dorsal bundles of carpels while smaller bundles travel inwards. The inner three small vascular bundles bifurcate and form six placental bundles of three carpels. Similarly there are two very small traces on either side of septal nectary which are missed to report by Mahabale and Chennveeraiah (1962) in D. montanum. At distal end of ovary the placental bundle disappear but the dorsal bundles continue upto the base of style.

Thus all the Dipcadi species under study have simple vasculature. Course of vasculature in D. montanum studied by Mahabale and Chennaveeraiah (1962) was also found in D. saxorum, D. concanense, D. ursulae etc. There was difference only in the number of traces in perianth lobe, the level at which stamens seperate from perianth and the length of perianth tube. Among the species studied D. saxorum could be easily distinguished from other species on anatomical characters such as oval

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Vascular bundles and perianth lobes with 3-5 vascular traces while in remaining species the vascular bundles are radially elongated and perianth lobes are also with more than 5 vascular traces.

Critical studies on external morphology,cytology and anatomy of Dipcadi species have revealed that there is need to reconsider the specific status of certain species. As discussed in previous pages, the author is of the opinion that D. ursulae, D. maharashtrensis and D.montanum belong to single species viz. D. montanum . D. ursulae and D.maharashtrensis are simply variants of D. montanum and they do not deserve even status of variety. Therefore D.ursulae and D. maharashtrensis are reduced to D.montanum.

D.concanense and D. saxorum are very distinct and endemic species. They are restricted in distribution and deserve conservation. South Africa is probably a centre of dispersal (and origin?) for Hyacinthaceae (stedje and Nordal, 1987), however western ghat of India seems to secondary centre of dispersal and evolution at least for genus Urginea (Dxit and Yadav 1989, Yadav and Dixit,1990) and Dipcadi. (Dixit et al. 1991).

(F) Embryology :

All the species of Dipcadi under study have typically trimerous bisexual flowers with 6 lobed perianth, 6 stamens and 3 carpels. The ovary is trilocular with many bitegmic,

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crassinucelate, anatropous ovules in two rows in each locule on axile placenta. The ovary is three angled, with long hollow style and trilobed papillate stigma. All the floral characters are typical of family Liliaceae.

There are three septal nectaries. They show similar developmental events as in Dipcadi montanum and othermembers of scilleae (Mahabale and Chennaveeraiah 1961, Johri,1966. Patil B.R. 1988). Septal nectaries are well known in monocot families such as Liliaceae, Muscaceae, Amaryllidaceae and Tridaceae (Fahn, 1969). The septal nectaries start developing at the megaspore stage. They are lined by 2-3 layers of secretary parenchymatous cells with prominent nucleus and dense cytoplasm. At the time of mature embryo sac when flowers open, the septal nectaries start signs of degeneration. After fertilization the septal nectaries are completely disorganised.

Long hollow style is characterized by wet stigma. The stigma is initially trilobed which becomes six lobed. The lobes are closely appressed with each other. The stigma is papillate. The papillae are clavate, densely cytoplasmic and uninucleate. Initially they posses cuticular cap. After wards before pollination the cuticular cap breaks and secretion of stigmatic substances takes place. Thus stigma becomes wet and receptive. Thestyle encloses a tri-radiate

canal which is lined with transmitting tissue. The cells of transmitting tissue are vertically elongated and stained dark byPAS reaction. Similar type of style and stigmatic structures have been reported by Johri (1966) in Urginea and other members of Liliaceae. During maturation of stigmatic papillae, he observed an increase in nuclear volume to six times in Aloe and Urginea. Polyploidy as a result of endomitosis in the stigmatic papillae was first reported by Tschermak - Woess (1959) in Spironema fragrans.

Phenological events in all the Dipcadi species are similar except minor variation in time of flowering. with onset of monsoon the bulb sprouts out and produces leaves. Within 3-4 weeks the inflorescence emerges out The species viz. D. concanense and D. saxorum which grow on somewhat rocky substratum (more xeric condition) show early flowring and fruiting than species viz. D.montanum D. ursulae growing on plateaus at higher altitudes. Flowering and fruiting of all the species is found to be overlapping. It takes place during July to September depending upon onset and amount of rains.

Capsule dehiscence takes place during August end or in September. The seeds have no dormancy and germinate soon after dehiscence. They form small bulbs and survive in the form of bulbs in dry season of year. In many Liliaceous members such as Iphigenia sps., Urginea sps Scilla hyacinthiana the seeds are non-dormant and show

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germination both in field and laboratory immediately after dispersal (Khare, 1978; Lugade, 1987; Patil B.R. 1988 and present investigation). It seems that the members of Hyacinthaceae have non dormant seeds which germinate soon after dispersal and survive the following dry period in the form of small bulbs.

The anther is tetrasporangiate. The anther development is of monocot type. Anther wall is four layered consisting of epidermis, endothecium, middle layer and tapetum. Epidermis is persistant still anther dehiscence. Endothecium develops fibrous thickening before anthesis and become prominent wall layer in mature anther. The fibrous thickenings also develop in other cells adjoining endothecium towards the connective. Anther dehisces longitudinally by a well organised stomium. Middle layer just inside endothecium is ephemeral. During divisions of primary sporogenous cells the middle layer gets crushed. During meiosis of microspore mother cells mere traces of middle layer are seen.

Initially the tapetal cells are uninucleate and have dense cytoplasm. During phrophase of microspore mother cells the tapetal cells become binucleate. The nuclei may fuse again and form uninucleate condition. The tapetal cells start degenerating during pollen tetrad

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stage. Gradually the tapetal layer gets disorganised during enlargement and further developkment of microspores and anther. Tapetum is of secretary type. The development of anther wall closely resembles with D. montanum (Mahabale and Chennaveeraiah, 1962) and Urgina razi and U. polyantha (Patil, 1988). Microspore mother cells undergo normal meiotic divisions. The species showed 6 bivalents confirming 12 as diploid number (Kanmani, 1975; Dixit et al. 1991). Successive type of division of microspore mother cells give rise to isobilateral tetrads. Decussate, T shaped or linear tetrads observed in Dipcadi montanum (Mahabale and Chennaveeraiah, 1962) were not observed in D. concanense. However linear tetrads were observed in D. saxorum. According to Vogel (1947) linear, T shaped and decussate tetrads are not so rare and occur in many monocotyledons.

As the microspores grow, they separate from tetrads. The tapetum gets disorganised and nucleus of microspore come to lie at one end of the pollen grain. It divides mitotically forming vegetative cell and generative cell. The pollen grains are shed in two celled condition. The pollen grains are monocolpate and reticulate. Monocolpate pollen grains are most common in Hyacinthaceae.

The ovary is tricarpellary, syncarpous, superior, triloculed with many ovules in two rows in each locule on

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axile placenta. The ovules are antropous, bitegmic and crassinucellate. The micropyle of the ovule is formed by inner integument alone as in other members of Liliaceae (David, 1966). The funicular strand extends upto the base of the nucellus where it gets connected to a group of nucellar cells called hypostase. An elevated mound like out growth called obturator is developed at the base of funiculus on placenta which is lined by columnar epithelial cells with dense cytoplasm and dark staining ability. It lies near the micropyle of ovule and serves as a bridge for pollen tube to enter into the ovule. Ovule arises as small mound on lateral side of placenta. Before initiation of integument, hypodermal archesporial cell gets differentiated. It divides periclinally giving rise to primary parietal cell and megaspore mother cell. The primary parietal cell gives rise to 2-3 layered parietal tissue. The megaspore mother cell undergoes normal meiotic division giving rise to linear tetrad of four megaspores. Besides linear tetrads, occurence of linear oblique and T shaped tetrads is reported in D. montanum (Mahabale and Chennaveeraidh, 1962), however, these types were not observed in D. concanense. T shaped tetrads are also recorded in Urginea (Maheshwari, 1932); Capoor, 1937; Patil B.R.1988) Ophiopogon intermedius (Mohana Rao and Kaur, 1979) and Scilla peruviana (Datta and Prakash Rao, 1975). Usually

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it is chalazal megaspore whichis functional, however, rarely sub chalazal megaspore showed enlargment. Such abnormalities are also observed in D. montanum (Mahabale and Chennaveeraiah, 1962) Urginea indica (Maheshwari,1932) Polygonatum Verticellatum (Stenar, 1953). The nucleus of chalazal megaspore divides mitotically for three times forming binucleate, four nucleate and finally eight nucleate embryo sae. The development of female gametophyte is of Polygonum type.

Mature embryo sac consists of egg apparatus, polar nuclei and antipodals. Egg apparatus consists of two synergids and one egg. The two polar nuclei fuse and form secondary nucleus which lies just above antipodals. The three antipodals lie in a pouch at chalazal end. Such pouch is also formed in Scilla (Datta and Prakasa Rao, 1975) and Dipcadi montanum (Mahabale and Chennaveeraiah, 1962).

Fertilization is of perogonous type. The pollen tube remains persistant for long time after fertilization. Persistant pollen tubes are also observed in Dipcadi montanum (Mahabale and Chennaveeraiah, 1962). Endosperm formation is of helobial type. This type of endosperm is also reported in D. montanum (Mahabale and Chennaveeraiah, 1962). Although embryogeny has not been studied in details in D.concanense however Mahabale and Chennaveeraiah (1962) have reported caryophyllad type of embryogeny in D. montanum. According to them embryological events of genus Dipcadi strongly supports its inclusion in Scilloideae of Liliaceae.