DISCUSSIONS

Morphology and distribution :

Genus Urginea with about 100 species (Airy-Shaw, 1966) is distributed along medditeranean sea-coast, Europe and India. Cytogeographical studies of Hyacintheae in Africa south of the Sahara by Stedje & Nordal (1987) have revealed that Africa is probably a centre of dispersal (and origin ?) for the genera such as Albuca, Dipcadi, Drimia, Urginea and Drimiopsis. Most of the species of Urginea grow along coastal region in sandy soils, however, some species are also found to be growing in interior areas such as plateaus, hilly region and waste lands. It is highly polymorphic genus and shows significant variations in morphological characters in different populations of same species growing in different regions, soils and climatic conditions. There are no good characters to delimit different species and therefore, there is controversy about species and their total number.

In India, so far 9 species of Urginea have been described. However, according to Deb and Dasgupta (1987) there are only five species viz. U.congesta, U.razii, U.polyantha, U.indica and U.polyphylla. They have reduced U.coromandeliana, U.wightiana, U.govindappae and U.nagarjunae to U.indica. Boraiah and Fatima (1982) do not agree merge of U.govindappae to U.indica and similar controversy may arise in case of other Indian species such as U.coromandeliana and U.nagarjunae. Therefore, experimental work on these species will prove to be of importance in understanding interrelation of different Indian species and their populations.

Except U.polyphylla all five species of Urginea have been reported from Maharashtra. Urginea razii (Ansari) Deb & Dasgupta (1987) com.nov. is known only from its type locality i.e. Diva Ghat in Poona district and is restricted in its distribution and seems to be endemic to Maharashtra. Urginea congesta has got restricted distribution and found only in drier parts of eastern Maharashtra. Urginea polyantha seems to be comparatively widely distributed in Maharashtra. Urginea indica has got wide distribution in Maharashtra as well as in India extending from Tamil Nadu to Himalaya.

Urginea indica has diploid, triploid and tetraploid (former U.coromandeliana) populations. The distribution of different cytological races showed definite relation between their geographical distribution and ploidy level. Diploid and triploid populations are found along costal region of Konkan of Maharashtra while tetraploid populations are found on east side of Sahyadri growing in dry rocky areas where there is extreme aridity in summer. Triploid populations are restricted to sandy soils of costal region while diploid population grows mixed with triploid populations as well as interior areas of Konkan. Triploid populations are not found growing in interior area. Thus Triploid populations are restricted to costal region and tetraploid populations are found in arid zone of Maharashtra.

According to Hagerup (1932) the polyploids are more tolerant of extreme ecological conditions than their diploid relatives. Shimotomai (1933) and Rohweder (1937) concluded that polyploid is favoured by existence along the sea coast. Tischler (1937) found a high percentage of polyploid in the halophytic flora of certain islands and from that concluded that polyploidy is associated with adaptation to the severe conditions of saline habitats. Triploid populations of U.indica grow in saline conditions and probably adapt to salinity through ploidy level.

Tetraploid populations of U.indica grow in extremely dry rocky areas of Eastern Maharashtra and this part of Maharashtra receives comparatively low rainfall. In general, the polyploids are considered to be hardier and better adaptable to extreme climatic conditions (Hagerup, 1932; Tischler, 1935; Muntzing, 1936; Love and love, 1942; 1943, 1953; Stebbin, 1950). Similar correlation between ploidy-level and geographical distribution has been observed in Scilla hyacinthiana (Sheriff and Rao, 1981).

Thus out of five species, U.congesta, U.razii, U.polyantha and tetraploid populations of U.indica are found in drier parts of Maharashtra on eastern side of Sahyadri while diploid and triploid populations of U.indica are found only on western side of Sahyadri where rainfall is high. U.polyphylla has not been reported by any worker after Hainy and wild and it's existance in Maharashtra seems to be doubtful.

Hooker has reported two groups in Indian species of *Urginea* such as *Synanthus* and *Hysteranthus*. According to Hooker (1892), Gamble (1928) and Deb and Dasgupta (1974, 1981) *U.indica*, *U.polyantha* belong to hysteranthus group while *U.polyphylla* and and *U.congesta* belong to synanthus group. Rajgopal and Reddy (1987) reported that *U.congesta* belongs to hysteranthus group. Their observations have been confirmed by present author both in the field as well as in cultivated plots through continuous observation for three subsequent years. *Urginea razii* is reported as hysteranthus species and therefore, all Indian species of *Urginea* are hysteranthus except *U.polyphylla* whose existance seems to be doubtful.

It is interesting to note that the time of flower opening is peculiar and must have played important role in specialization. The flowers of *U.congesta*, *U.razii* and *U.polyantha* remain open in day time. The flowers start opening in morning hours, remain open in day time and close by evening. The flowers of diploid, triploid and tetraploid populations start opening during evening hours, remain opened in night and close by morning. Thus pollination in former three species takes place in day time while in later species, it is during night. Thus there is reproductive isolation of *U.indica* from *U.congesta*, *U.razii* and *U.polyantha*. The anthesis time of *U.congesta* and *U.razii* was observed at Ca 10 a.m. however, in *U.polyantha* the time of anthesis was observed to be at Ca 4 p.m. on previous day of flower opening. It matches to that of U.indica and thus indicates closer relationship which is also confirmed by crossing experiment between these two species (Dixit & Yadav, unpublished). Based on time of flower opening, Indian species could be grouped into two groups such as day blooming and night blooming species. Similarly on the basis of flower opening characteristics Waisel (1972) grouped costal plants into two groups such as night flowering and day flowering species. According to him U.maritima is night flowering species. Thus in India diploid triploid and tetraploid populations of U.indica form a night blooming group and U.congesta, U.razii and U.polyantha form a day blooming group. Reproductive isolation through differences in time of flower opening and pollination seems to be one of the important factors in speciation of genus Urginea and needs observations on other species of Urginea. Critical studies have proved that reproductive barriers have played role in species formation (Clausen et al., 1939; Dobzhansky, 1941; Mayr, 1942). Although role of seasonal isolation in speciation has been studied in many species (Stebbin, 1950), isolation of species due to differences in flower opening has not received critical attension.

Among the species, U.razii showed smallest bulbs followed by U.congesta and U.polyantha while U.indica had larger bulbs than all other species. Largest bulbs were observed in triploid populations of U.indica. U.razii and U.congesta showed low rooting ability, U.polyantha showed mediam ability to root while

U.indica showed maximum ability to produce roots. Different populations of U.indica showed largest rooting disc among the species. Leaves of U.razii are very distinct. They are narrowly linear and are always erect. Leaves of U.polyantha and U.congesta are linear and usually spread on ground and are often twisted. Leaves of U.indica are broadly linear or lorate and erect however, tetraploid populations of U.indica showed erect, ascending as well as spreading leaves. Bulb of U.congesta usually produces 3 leaves per year and maximum leaves per bulb per year are produced by U.indica. The other species fall in between these two species. Urginea razii and U.congesta are slow growing species while U.indica is a fast growing species and U.polyantha fall inbetween these two conditions. U.congesta seems to be most slow growing Indian species which has got restricted distribution. It's bulbs are umbonate peculiar to it. The size, shape of plant, bulb and leaves vary ~~ies~~ in different species as well as different populations of the same species.

Shortest scape was observed in U.congesta followed by U.razii, U.polyantha, tetraploid population of U.indica and longest in diploid and triploid populations of U.indica. Pedicel length of flower was shortest in U.congesta followed by U.razii, U.polyantha, tetraploid population of U.indica and longest in diploid and triploid populations of U.indica. U.polyantha showed smallest flowers followed by U.razii, U.congesta and U.indica. There was no significant difference between flower size of diploid, triploid and tetraploid populations of Urginea however, slightly larger flowers were observed in triploid populations. Ovule number per ovary was lower in U.congesta, U.razii and U.polyantha, however, it was higher in U.indica.

Among the species of Urginea, U.congesta showed largest seeds while U.razii showed smallest seeds. The seeds have no dormancy in any species and germinate immediately after dispersal if water is available. Seed germination in U.indica has been studied by (Khare, 1978). U.polyantha showed maximum production of seeds per plant which explains its wide occurrence in Maharashtra as compared to U.razii and U.congesta. U.razii showed lowest seed production among the species and may be correlated with its restricted distribution. Diploid populations of U.indica produce fairly good number of seeds, however although there is regular flowering in triploid populations, there is no fruit and seed formation. The flowers are shed and inflorescence dies off which is indicator of its triploid nature. Tetraploid populations of U.indica from various localities produce fairly good number of seeds and reproduce sexually however, it has been reported that the tetraploid populations (U.coromadelicm) at Aurangabad do not produce viable seeds (Naik, 1976).

U.congesta, U.razii, U.polyantha and diploid and tetraploid populations of U.indica, reproduce sexually in nature. U.congesta, U.razii, U.polyantha did not show vegetative reproduction.

Diploid and tetraploid population of U.indica showed tendency to produce daughter bulbs. Tetraploid population of U.indica showed high tendency to produce daughter bulbs and in addition to reproduction through seeds it also propogates through daughter bulbs. Triploid population of U.indica showed strong ability to produce daughter bulbs and it is the only means of propagation as there is no seed setting. It is well known fact that cytologically unstable species which cannot reproduce sexually take up some means of vegetative propagation for their survival. Triploids are reported to occur commonly in plants with various kind of natural vegetative reproduction (Darlington, 1929), and their occurrence in the closely allied genera of Hyacinthus, Tulipa and Scilla makes it highly probable that triploids are common in Urginea also. Triploids of U.indica are reported by Raghavan (1935), Raghavan & Venkatasubban (1940, 1940 b), Sen (1974), Jha and Sen (1983). The triploid population of Scilla hyacinthiana reproduce underground bulbs and bulbils (Sheriff and Rao, 1981) and propagates through them.

Cytology :

All the four species of Urginea showed 20 as diploid chromosome number however, triploid and tetraploid populations were also observed in U.indica. The genus has been extensively studied cytologically (Raghavan, 1935; Maugini, 1953,1956,1960; Maugini and Maleci, 1974; Battaglia, 1957 a, 1957 b; de Wet 1957, Love, 1964; Datta, 1966; Zaman & Khaleque, 1978; Naik,1973, 1976; Sen, 1973, 1974; Jha and Sen, 1983 a, 1983 b) and so far chromosome number for about 30 species is known (Sharma, 1972) out of which about 26 species showed 20 as diploid chromosome number which seems to be dominating somatic chromosome number in *Urginea* species. In general the chromosomes are telocentric or subtelocentric in Indian species. Based on chromosome morphology and Levitzky's (1931) theory, Nwankiti (1983) classed the genus *Urginea* as a highly advanced member of the Liliaceae. Chromosome morphology in different Indian species showed similarities in general and indicate close relationship. Karyomorphological studies on Indian species of *Urginea* by Dixit and Yadav (unpublished) indicate that *U.indica*, *U.polyantha*, *U.govindappae* and *U.coromandeliana* are closely related species and form a species complex. Similar kind of species complex in *U.indica* from West Africa has been reported by Oywole (1987).

In addition to diploids of *U.indica*, triploids and tetraploids are reported by many workers (Raghavan, 1935; Raghavan and Venkatasubban, 1940 a, 1940 b; Sen 1973; 1974; Naik, 1973, 1976; Jha and Sen, 1983 a) and hexaploids by Jha and Sen (1983a). Polyploid series is also reported in *U.maritima* (Battaglia 1957 a, 1957 b), however, in both *U.indica* and *U.maritima* diploids are most common and widely distributed.

In general diploids of *U.indica* are more common and widely distributed throughout India, triploids being restricted to peninsular India, tetraploids to south and eastern India and hexaploids to south coast (Jha and Sen, 1983). Jha and Sen (1983) also reported diploids, triploids and tetraploids from same locality such as Banglore in Karnataka, Pune in Maharashtra and Mysore however, in Maharashtra these three populations showed distinct distributional pattern and were never observed to be growing in same locality. The triploids were observed to be restricted to costal area, diploids were found to be mixed with triploid as well as growing separately in interior areas of Konkan while tetraploids were found only in drier parts of eastern Maharashtra. The present investigator is of opinion that triploids are adapted for saline conditions while tetraploids are adapted for dry xeric conditions of interior areas of the country. There are ample examples where polyploidy has conferred wider adaptability (Hagerup, 1931; Tischler, 1935; Muntzing, 1936; Love and Love, 1943; Cain, 1944).

Diploids must have also salt tolerance

Kamble and Ansari (1976) studied the karyomorphology of *U.polyantha* but did not find β chromosome in the population studied by them however single β chromosome was observed in some plants from Shivaji University Campus. Diploid populations of *U.indica* from Ganapati Pule showed 3 β chromosomes. β chromosomes ranging in number from 1-8 have also been reported in *U.aurantiaca* (Battaglia, 1958), *U.epigea* (de-Wet, 1957), *U.fugax* (Martinoli, 1949; Battaglia, 1957,1964; Battaglia and Gaunti, 1968), *U.indica* (Raghavan and Venkatasubban, 1940, Ayyangar, 1969; Sen, 1974), U.maritima (Geiter, 1929; Raghavan & Venkatasubban, 1940), U.lydenburgensis and U.rubella (de-Wet, 1957).

Palynology :

Liliaceae is a comparatively eurypalynous family and possess usually monosulcate pollens (Erdtman, 1971). Different Indian species of Urginea have mono-colpate pollengrains with fine to coarse reticulate ornamentation. The pollen grains showed variations in pollen size frequency classes and wall ornamentation. U.congesta showed smallest pollen grains among the Indian species of Urginea followed by U.razii and U.polyantha while diploid and tetraploid populations of U.indica showed largest pollen grains. The pollen grains of U.congesta, U.razii and U.polyantha showed fine reticulate ornamentation while diploid and tetraploid populations of U.indica showed coarse reticulate ornamentation. There are several examples where pollen morphology has helped to understand the interrelationship of taxa and to solve taxonomical problem (Nair, 1964; Sivarajan, 1980). Pollen morphology has been used to identify species of Ipomoea and Polygonum (Hedberg, 1947), Anemone (Erdtman, 1952), Gnetum and Ephedra (Nair, 1964), Cordia (Nowicke and Robyns, 1974), Bauhinia (Nair, 1974), Zizyphus (Nehra and Chauhan, 1985) and many more may be cited. Pollen size frequency curves have been effectively used in identification of various species of Podocarpus (Martin, 1959). Although different Indian species of Urginea could not be identified on basis of pollen morphology, two groups of species could be recognised viz. U.congesta, U.razii and U.polyantha with small pollen grains and fine reticulate ornamentation while diploids and tetraploids of U.indica with large pollen grains and coarse reticulate ornamentation. Pollen morphology indicates that diploids, triploids and tetraploids of Urginea are closely related. U.razii and U.congesta are more distant to U.indica than U.polyantha.

All the species of Urginea showed high pollen fertility except triploid populations of U.indica. High pollen sterility (40-50%) and great size variation indicate the triploid nature of the population. The pollen fertility and size variation could be used to assess triploid nature of U.indica in flowering stage.

Tetraploid populations of U.indica showed equally high pollen fertility as that of diploid population, indicative of stable nature of the population. In addition to high pollen fertility, tetraploids showed production of fairly good number of viable seeds, propagation through sexual means and geographical isolation which support the recognition of U.coromandeliana as a distinct species from that of U.indica by Hooker (1892), Gamble (1928). Inspite of morphological differences and above mentioned characters, crossing experiments showed that tetraploids could be easily crossed with diploids however, even *U.polyantha* (which is well established species) crosses equally well with diploid and tetraploid populations of *U.indica* which indicates close relationship between tetraploids and diploids of *U.indica* and *U.polyantha* forming a species complex (Dixit and Yadav, unpublished). However, Naik (1976) reported abnormal behaviour of meiocytes, high pollen and sexual sterility in tetraploid population (former *U.coromandeliana*) of Aurangabad. He considered that *U.coromandeliana* is a autotetraploid and should be merged into *U.indica.* Deb and Dasgupta (1974, 1981) considered *U.coromandeliana* as conspecific to *U.indica* and reduced to *U.indica.*

Usually pollen grains are shed in 2-celled condition however, in *U.congesta* few pollen grains in 3-celled condition were also observed at time of anther dehiscence. Such abnormalities are also reported in *Dipcadi* (Chennaveeraiah and Mahabale, 1959, 1966).

Anatomy :

Anatomical features of the scape exhibited more or less uniform pattern in all the investigated taxa. All of them have single layered epidermis covered with waxy coating and interspersed with stomata, 2-3 layered thin-walled parenchymatous hypodermis, few to many layered sclerenchymatous cortex and central ground tissue with scattered vascular bundles. Cells of hypodermis contain chloroplasts. The large vascular bundles are found in inner part of central parenchyma while small vascular bundles are found in outer zone of central parenchyma. The length of epidermal cell varied in different taxa and could be correlated with length of scape of different taxa i.e. U.congesta with shortest scape showed short epidermal cells while U.indica with longest scape showed long epidermal cells. The thickness of sclerenchymatous cortex and length of fibre cells varied in different taxa and could also be well correlated with the length and basal diameter of scape. The thickness of cortex and length of sclerenchymatous fibre cells increased with increase in length and basal diameter of scape from U.congesta to U.razii to U.polyantha to U.indica. Scape of tetraploid population of U.indica showed thickest sclerenchymatous cortex and longest fibre cells. Depending upon distribution of vascular bundles in ground tissue, two zones could be distinguished. The outer zone possesses many small vascular bundles while inner zone has 4-6 large vascular bundles. Total number of vascular bundles varied greatly in different taxa. Minimum number of vascular bundles was observed in U.razii (15) and U.congesta (18) while U.indica showed maximum number (33-40) of vascular bundles. Smallest vascular bundles were observed in U.razii and U.congesta, U.polyantha showed median sized vascular bundles while U.indica showed largest vascular bundles.

Leaf anatomical features are uniform in all taxa with some important variations in thickness of leaf, size of cells and total numberof vascular bundles per leaf. U.razii showed ridges on lower surface of leaf which are not found in any other species. Leaf epidermal cells exhibited more or less uniform pattern both on adaxial and abaxial face. The cells of epidermis are narrow and elongate in different taxa. The size of epidermal cells varied in different taxa. The leaves are isobilateral and amphistomatic. Stomatal density varied on adaxial and abaxial faces of same species however no significant variations were observed in stomatal index. Average stomatal density was highest in U.congesta followed by tetraploid of U.indica while in other two species (U.razii, U.polyantha) it ranged from 54-74 mm^{-2}. No significant difference was observed in stomatal index of different taxa which ranged from 50-57. The largest stomata were observed in tetraploids of U.indica (61 x 45 µm) followed by triploids of U.indica (45 x 35 µm). U.polyantha showed smallest stomata (32 x 23 µm).

Just below epidermis there is a single layer of palisade which is made up of vertically oriented rod-shaped Ø parenchymatous cells which contain numerous chloroplasts. Palisade is observed on both sides of leaf. Below palisade layer there are 2-3 layers of elongated cells which contain fewer number of chloroplasts. The central portion of leaf is occupied by water storage tissue which is made up elongated, large, rectangular parenchymatous cells devoid of chloroplasts whose long axes lie parallel to leaf surface. The vascular bundles run parallel to each other through water storage tissue. The total number of vascular bundles per leaf was minimum in *U.razii* (5) followed by *U.congesta* and *U.polyantha*. *U.indica* showed highest number of vascular bundles per leaf. Cells containing raphids were observed in all parts of plant even extending to style of ovary.

Although typical raphids are particularly characteristic of the foliar organs of monocotyledons (Montagu Drummond, 1965) are also found in scape, ovary wall, style and scales in *Urginea*. Probably acicular raphids provide mechanical protection against noxious animals (Haberlandt, 1965).

Kamble and Ansari (1977) gave a brief account of anatomy of four species of *Urginea* and indicated it's importance in identification of species however, no attempts were made to interpret interrelationship of the taxa studied by them. Observations on anatomy of leaf and scape suggest that *U.congesta* and *U.razii* to be more departed species from *U.indica* than *U.polyantha*. This interrelationship is also supported by crossing experiment on the species (Dixit and Yadav unpublished). Similarly Naik and Nirgude's (1981) observations on anatomy of *Chlorophytum* species supported cytological grouping of the species in many respects.

Observations on morphology, phenology, time of anthesis, palynology and anatomy suggest the close relationship of

U.polyantha with U.indica than U.congesta and U.razii. U.congesta stands more apart from U.indica as well as from two other species. The diploid, triploid and tetraploid populations show close similarities. This interrelationship is supported by crossing ability of the species. U.congesta did not cross with any other species, U.razii could be crossed with U.indica only with hot water and GA treatment while diploid, and tetraploid populations of U.indica could be crossed with U.polyantha without any treatment (Dixit & Yadav). Thus, experimental interspecific hybridization in Urginea species indicates the close interrelationship between tetraploids and diploids of U.indica and U.polyantha, weak incompatability reaction between U.indica and U.razii and distant relationship of U.congesta with other species of Urginea under investigation. Based on morphology, phenology, time of anthesis and flower opening, palynology, anatomy and hybridization experiments following relative relationship is suggested.

Adapted for saline condition		Adapted for dry arid conditions
		U.congesta
		U.razii
		U.polyantha (2n = 20)
U.indica (Triploids) 2n = 30.	U.indica (Diploids) 2n = 20	U.indica {(Tetraploids 2n = 40 (U.coromandeliana)} (Xeric dry condition)

Deb and Dasgupta (1974,1981, 1987) reduced *U.coromandeliana* to *U.indica* which is also supported by Naik (1976), however, morphological differences, cytological differences, pollen fertility, ability to reproduce sexually and geographical isolation suggests and supports (Hookers, 1892) recognition as a separate species.

Embryology :

Embryology of *U.razii* and *U.polyantha* has been investigated. Both the taxa exhibited same embryological events. The embryology of these two taxa closely resembles with that of *U.indica* (Maheshwari, 1932; Capoor, 1937) except for few minor differences.

U.razii and *U.polyantha* are day blooming species. Flowers of both species start opening in morning hours and open fully by 12 a.m. The flowers remain opened upto 3.0 p.m. and close by 4.00 p.m. Around 12 a.m. the septal nectaries secret nectar which is seen as three droplets corrosponding to three septal nectaries. Septal nectaries are common in monocots such as family Liliaceae, Muscaceae, Amaryllidaceae and Iridaceae (Fahn, 1969). During same hours of flower opening the stigmatic papillae secret secretions, stigma becomes wet and start glistening in bright midday light. Small insects in search of nectar visit the flowers and bring about pollination. Pollens soon germinate on the stigma and pollen tubes grow down through stylar canal. The pollen grains are monosiphonous. Pollen tubes entering the ovules were seen just after 3-4 hours of pollination. In both U.razii and U.polyantha the anthers are tetrasporangiate. Microspore mother cells show successive type of cell division which is characteristic of many monocotyledons. Isobilateral tetrad's are formed and the pollen grains are usually shed in 2-celled condition however, in U.congesta occassionally 3-celled condition of pollen at anther dehiscence was observed. Such abnormalities are also recorded in Dipcadi (Chennaveeraiah and Mahabale, 1962), Chlorophytum, Polygonatum and Tulipa (Davis, 1966). Pollen grains are monocoplate as in the species of Massonia, Scilla, Ornithogalum, Veltheimia of the group Scilloideae (Erdtman, 1971) and show fine to coarse reticulate ornamentation (Deb and Dasgupta, 1974).

Anther wall consists of an epidermis, endothecium, single middle layer and glandular tapetum. Epidermis is persistent still anther dehiscence. Endothecium develops fibrous thickenings before anthesis and becomes a prominent wall layer. There is single middle layer which is ephemeral and disorganises very early when meiocytes enter into meiotic division. The cells of glandular tapetum become binucleate when megaspore mother cells undergo meiotic divisions. The development of anther wall closely resembles with that of Dipcadi (Chennaveeraiah and Mahabale, 1962), and Ophiopogon intermedius (Mohana Rao and Kaur, 1979). Microspore mother cells undergo normal meiotic divisions.

Both species showed 10 bivalents confirming 20 as a diploid chromosome number. Successive type of divisions of microspore mother cells give rise to isobilateral tetrads. Anther dehisces by vertical slit.

The ovary is tricarpellary syncarpous, superior, triloculed with many ovules in two rows in each locule on axile placenta. The ovules are anatropous, bitegmic and crassimucellate. Both the species have trilobed stigma with uninucleate papillae. The style is hallow and the stylar canal is lined with transmitting tissue and filled with fluid at the time of pollination. The parenchyma cells containing raphids occur in style and ovary wall. Johri (1966) observed raphid cells in upper part of style in U.indica. Similarly Johri (1966) studied ontogeny, distribution, cytology and fate of transmitting tissue before and after the growth of pollen tubes in U.indica which showed close similarity with U.razii and U.polyantha. The micropyle of ovule is formed by inner integument alone as in other members of Liliaceae (Davis, 1966).

Development of female gametophyte is similar to that of U.indica (Maheshwari, 1932; Capoor, 1937). The archesporial cell cuts off a primary parietal cell and archesporial initial. The primary parietal cell forms parietal layer. Two archesphorial initials are sometimes observed in same ovule which are also reported in U.indica by Maheshwari (1932). Capoor (1937) observed the primary parietal cell assuming a sporogenous function so that two megaspore tetrads in same row in *U.indica*. Normal meiotic division of megaspore mother cell give rise to linear or T-shaped tetrad of 4 megaspores. The frequency of T-shaped tetrads was observed to be more in *U.razii* than *U.polyantha*. In addition to linear tetrads, T-shaped and decussate tetrads have been reported in *U.indica* (Capoor,1937). T-shaped tetrads are also recorded in *U.indica* (Maheshwari,1932; Capoor, 1937), *Dipcadi* spp. (Chennaveeraiah and Mahabale, 1966), *Ophiopogon intermedius* (Mohana Rao and Kaur, 1979), *Scilla peruviana* (Datta and Prakasa Rao, 1975). Usually it is a chalazal megaspore which give rise to polygonum type of embryosac however, rarely subchalazal megaspore showed the enlargement which was also recorded in *U.indica* (Maheshwari, 1932). Normal type of embryosac seems to be characteristic of genus *Urginea* however, five different types of embryosac development has been reported in Liliaceae (Romanov, 1959). The nucleus of chalazal megaspore undergo three mitotic divisions forming 8 nuclei which soon organise into normal embryosac. The embryosac forms a pouch at chalazal end in which 3 antipodal lie. The two polar nuclei fuse and form secondary nucleus which lie just above antinpodals. The pouch is also formed in *Scilla* (Datta and Prakasa Rao, 1975) and *Dipcadi* (Chennaveeraiah and Mahabale, 1962). Squash technique (Langer and Koul, 1982) was found to be ideal to study nuclear cycle upto 4 nucleate embryosac, however, entire embryosac could not be obtained probably because of pouch of embryosac which gets detached during squashing. Egg apparatus consists of an egg and two synergids. The synergids showed filiform apparatus which is also reported in *U.indica* (Capoor, 1937). Although Maheswari (1932) reported ~~that~~ the antipodals to be ephemeral in *U.indica*, they were found to be conspicuous and persistant in both taxa under investigation.

Fertilization is porogamous. A mound like outgrowth (obturator) at the base of funiculus serves as a bridge for pollen tubes to reach the micropyle of ovule. Hypostase becomes prominent after fertilization. Endosperm formation in *U.razii* and *U.polyantha* is of Helobial type, however, it is difficult to observe wall formation between two first formed endosperm nuclei and chalazal chamber. Davis (1966) also reports that the endosperm formation in Liliaceae is of Helobial type and small chalazal chamber is usually ephemeral. According to him the report of nuclear endosperm in *Asphodelus*, *Colchicum*, *Iphigenia*, *Liriope*, *Scilla* and *Tricyrtis* is probably due to overlooking of small chalazal chamber. In majority of the members of scilloideae, the endosperm development is of Helobial type (Cave, 1953). Helobial endosperm is also reported in *Dipcadi* species (Chennaveeraiah and Mahabale, 1962).

Although embryogeny has not been studied in detail the preliminary observations show that the first division of zygote is transverse forming Ca and Cb. Basal cell forms suspensor. The apical cell undergoes two vertical divisions at right angle to each other forming 4 cells. Transverse division forms two tiers of 4 cells each forming 8 celled proembryo. The cell of proembryo undergo periclinal divisions forming globular embryo which grows downwards occupying entire length of seed.

Mature seed consists of central cylindrical embryo surrounded by cellular endosperm. The seed coat is made up of both integuments. The epidermal cells of outer integument develop reticulation and become black. Seeds do not possess dormancy and reported to be light sensitive (Khare, 1978).