DISCUSSION

**Cypripedium:** The present count of 2n=20 for *Cypripedium cordigerum* is in conformity with the earlier reports for the species (cf. Table 1). Different populations presently worked out did not show any remarkable variation in the details of their karyotypes which consist of 8 metacentric and 2 acrocentric chromosome pairs with a secondary constriction in a metacentric pair. These observations are in agreement with those of Vij and Mehra (1974a) and Vij and Gupta (1973).

**Epipactis:** All the three species of *Epipactis* worked out at present possess 2n=40, which confirms the earlier reports for them (cf. Table 1). However, in *E. latifolia* other numbers viz., 2n=36 and 2n=36, 44 have also been reported, the species thus being cytologically variable. In gross karyotypic morphology *E. latifolia* and *E. royleana* resemble each other. But the karyotypic formulae, range of chromosome size and total chromatin length in the two is not the same. All the three species are at diploid level on the base number x=20. This view is not in agreement with the suggestion of Darlington and Mylie (1955) who postulated x=19, 16, 18, 19. Gene mutations and chromosomal repatterning seem to have played an important role in speciation of this genus.
**Neottia:** Neottia Inavatii has been worked out for the first time. Its chromosome number is 2n=42. The chromosomes are medium-sized which is characteristic of the genus. Present count of n=20 and 2n=40 for *N. listeroides* confirms the findings of some earlier workers (cf. Table I), but differs from that of Mehra and Pal (1961) who found n=22. Mehra and Vij (1972a) suggested x=10 as the base number for the genus, while Darlington and Aylle (1955) suggested x=9. The chromosome size as judged from meiotic cells in the two presently studied species seems to be identical. It is possible that *N. inavatii* may have evolved from *N. listeroides* as an aneuploid derivative.

**Goodyera:** The present count of 2n=30 for *Goodyera repens* confirms most of the previous reports (cf. Table I). But the species seems to be cytological variable since 2n=26, 32 (Heim 1941), Mehra and Vij (1975); n=15, 16 Vij and Gupta (1973); 2n=32 (Tanaka 1963) have also been reported.

**Ophrys:** Two cytotypes 2n=40, 2n=80 have been discovered in *Ophrys latifolia* thus confirming similar numbers reported earlier for the species (cf. Table I). Ploidy has affected the plant size. The tetraploids (2n=80) are gigantic as compared to the diploids (2n=40) but otherwise there are no qualitative differences.
<table>
<thead>
<tr>
<th>Name of Taxon</th>
<th>2n</th>
<th>Ploidy level</th>
<th>Total chromatin length in μm</th>
<th>Range of chromosome size in μm</th>
<th>TF%</th>
<th>Chromosomal types</th>
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</table>
Genera with more than one Base Number

Allium, x=3, 6, 7, 8, 13
Scatterer, x=11(10)
Tragacanth, x=6, 6, 12, 13, 13, 13
Polyodonatum, x=9, 10, 11, 14
Fritillaria, x=12 by fusion and fragmentation 9, 13.
Hyacinthus, x=6, 9, 14.
Ornithogalum, x=3, 3, 6, 7, 8, 9
Allium, x=7, 8, 9
Nerine, x=11, 12
Monochoria, x=14, 26
Crinum, x=13, 29
Iris, x=7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22 etc.
Grecus, x=3, 4, 5, 6, 7 etc.
Corypheidium, x=10, 11
Epipactis, x=10, 16, 18, 19
Nestea, x=16
Gooden, x=11, 14, 15
Orchis, x=16, 18, 19, 20, 21

The common base numbers range from 7 to 12. Darlington (1956) suggested 7 as the original base number for angiosperms. The same was considered likely by Raven and Khyos (1963) who found n=7 in Annonaceae. According to Grant (1963, cf. Menza, 1972) the original base number of angiosperms ranges between 7 to 9. Johnson and Briggs (1963, cf. Menza, 1972) suggested x=7 as original basic
which seems to have been the method in Allium. The explanation for the chromosomes of Polygonatum or Hosta seems somewhat different, all the small chromosomes sometimes have centrally located centromeres.

So far as the general chromosome morphology is concerned Tradescantia sagittata, species of Allium except a few, were found to possess least variation in chromosome size. Sharp chromosome disparity in the karyotype from size point of view was found in species of Hosta, Polygonatum, Butomus, Epipactis. An intermediate situation was found in some members of Iridaceae, Alliaceae, Hydrocharitaceae.

In some taxa, karyotype resembles very much at generic level as observed in Allium, Sagittaria, Pritillaria, Tulipa and Epipactis, but in others it is varied as seen in species of Allium, Polygonatum. In some species the karyotype shows polymorphism as discerned in Allium victoriae-reginae, A. schoenoprasum, Trillium govanianum, Eremurus himalaeus, Hydrilla verticillata, Hydrocharis dubia.

Detailed karyotypic studies of different populations of some species revealed conspicuous differences in appearance of karyotypes. In most of the polyploids, the basic set of karyotype changes as observed in Allium porrum. In Butomus umbellatus basic karyotype of diploid taxa has remained almost unaltered in the triploid taxon.

Occurrence of secondary constriction giving rise to a small or large satellite is common in various members of the genus Allium, family Liliaceae, Trilliaceae, Iridaceae.
and the genus *Allium*. The number and morphology of the satellite chromosomes vary in different species of the same genus. In most of the diploid species the mitotic complement includes only one such pair but there are cases with two pairs also. The latter is considered as the secondarily balanced condition (Mensink, 1940). In the polyploids, the number of satellite (also called nucleolar) chromosomes is usually correlated with the level of ploidy. As such most of the tetraploids have four satellite chromosomes e.g., *Allium tuberosum*, *A. griffithianum*, *A. porrum*.

But this correlation does not hold good for all polyploids as 9 satellite/nucleolar chromosomes in the hexaploid *Allium porrum* (great headed garlic) were observed in the present investigations. Khoshoo et al. (1969) found ten nucleolar chromosomes in hexaploid *Allium cepa var. porrum*.

In *Allium blanderum* and *A. thomsonii*, both tetraploid, only two satellite chromosomes have been detected. Present studies revealed that secondary constriction is usually a constant characteristic of a species, but not so of the genus. A secondary constriction when near the distal end of an arm gives rise to a terminal satellite, while when near the centromere it forms an interstitial satellite. The latter are reported for the first time in the species *Allium consanguineum* and *A. stracheyi*, which even otherwise resemble very much with each other. Nasir (1975) has considered *Allium stracheyi* as a synonym of *A. consanguineum*. Interstitial satellitization is also found in *Allium griffithianum*. 


Allium victoriaeae, A. porrum, A. sativum, Allium coeruleum.
while terminal satellitization is discerned in Allium
sagalexicum, A. cepa var. cepa, A. humile, A. tuberosum,
A. blanda, A. thomsonii, A. atropurpureum, Allium lanceolatum,
Iris germanica, I. kashmirica, Eremurus hispanicus, Hesperi
rampicues, Orontogalum umbellatum. When a secondary
constriction is in the centre of an arm and/or does not
involve small portion, satellitization term seems not to be
used. Such a condition has been observed in Hyacinthus
orientalis, Persicaria sps., Lilium polyphyllum, Polygonatum
verticillatum. The notion that with increase in size there
is an increase in the number of secondary constrictions can
be supported in the longest chromosome pair in Allium
victoriaeae, but not in other Allium sps. worked out
previously. The general morphology of the secondarily-
constricted chromosome is found to vary from species to species
in the same genus. Sometimes it becomes difficult to assign
which one would be the primary constriction and which is the
secondary, when both are of the same size. Mostly among
the species having large-sized chromosomes, the secondary
constrictions are fairly common.

Levitskaya (1931) was the first to observe the genus
Helobiaeae of Ranunculaceae which is quite primitive
possess chromosomes which differ little from each other
in size and have mostly median and submedian constriction.
He considered such karyotypes as generalised from which
various specialised ones have been derived. In the genus
Allium median or submedian chromosomes occur in some members of the section Scenoprasum which is primitive, but in members of the section Rhiziridium or Molium where there are advanced floral and vegetative characters the karyotype is also advanced.

In higher plants two types of specialization seem to have taken place. The first involves reduction in length of one of the chromosome arms altering median chromosomes first to submedian and then to subterminal ones. In the second type there is reduction in size of some chromosomes in relation to others of the same set so that the resultant karyotype possesses chromosomes of very unequal size (Stebbins, 1939).

Allium victoriaezae among the presently studied members of the genus Allium seems specialized in morphological characters as compared to the related species, and it possesses asymmetric karyotype. Same holds good for Iris kumanoensis which possesses asymmetric karyotype as well as specialised morphological features as compared to Iris kashmiriana, I. germanica, and I. ensata. Alismataceae having the gynoezial situation of many pistils and ovules scattered over the inner wall of the carpel is perhaps an example of the more primitive type to be found among all monocots and dicots. Hutchinson (1934) treated it as a representative of ancestral progenitors of the liliaceous stock, while Bessey (cf. Lawrence, 1931) seemingly ignored its phylogenetic significances. The family Liliaceae includes plants with
rhizomes, corms or bulbs. "The primitive tribes are no doubt those with a rhizomatous root-stock" (Hutchinson, 1934). Species of *Hem.llum*, *Eremurus*, *Polygonatum* of Liliaceae having rhizomatous rootstock and other less specialised morphological features show asymmetric karyotypes, while that of *Paras* or *Trillium* of Trilliaceae, which are certainly specialised in their vegetative characters possess a symmetrical karyotype. On the other hand bulbous members like *Lilium*, *Fritillaria*, *Hyacinthus* are with asymmetric karyotype, and in most of the species which are specialised morphologically possess symmetric karyotypes. A peculiar intermediate in highly symmetrical and asymmetrical is represented by *Hemerocallis fulva* and *Ornithogalum umbellatum*.

Many instances of this nature have also been reported in literature. In the genus *Neophyllum* which possesses highly zygomorphic flowers, the more primitive species like *N. straphylospora* have the largest number of median and submedian chromosomes as compared to annual species like *N. nivalis* which possess the most specialised karyotypes both in form and relative size of the component chromosomes. Also in the two genera of Liliaceae *Narthecium* (Levan, 1935) and *Hieracium* (Cave and Breedley, 1943) the chromosomes are with apparently terminal centromeres. Both of them are rather specialised in regard to flowers as well as vegetative parts. On the contrary, in *Taraxacum*, *Yousae* and *Hieracium* considerable specialisation in external morphology is
associated with the retention of unspecialised and symmetrical karyotype (Stebbins, 1935).

*Allium schoenoprasum* and *A. fedtschenkoanum*, the two species among presently studied Alliums, with terminal centromeres in a pair of chromosomes have very reduced bulbs. In *Allium fedtschenkoanum* only a rudiment of the bulb is present and the size variation in karyotype is not remarkable. Such telocentric chromosomes are common in Alismatales and are responsible for asymmetry of the karyotypes. Generally speaking plants with asymmetric karyotypes have greater tendency towards the vegetative mode of reproduction and possess rootstocks.

It, thus, appears that symmetrical and asymmetrical karyotypes are not uncommon in both morphologically specialised as well as unspecialised plants. According to Stebbins (1935), generally the asymmetrical karyotypes are most common in plants which are usually specialised morphologically while symmetrical ones are prevalent in more or less generalised plants but nevertheless occur not uncommonly in morphologically specialised ones too.

Neither symmetrical or asymmetrical karyotype is advanced, seems difficult to judge. The Alismatales are regarded the most primitive, but have asymmetrical karyotypes. Every family has some of its members or almost all with asymmetric karyotypes. The reason for this increasing asymmetry in karyotypic evolution is due to unequal translocations, inversions involving the centromere,
duplications, deletions centric fusion or fission or fragmentation of chromosomes.

**MEIOTIC ABERRATIONS**

In most of the diploids there is a normal course of meiosis. In some members, particularly of the families Aliinaraceae and Butomaceae, the course of meiosis has been investigated with great difficulty. The difficulties in getting clear meiosis slides of taxa of Aliima have been stated many times earlier too (cf. Hagerup, 1944; Tschermak-Weiss, 1946; Castro and Wagner, 1950; and Björkqvist, 1968). The reason for this is stickiness of chromosomes. Even in spite of this it has been possible presently to make exhaustive studies in species of Aliima, Sagittaria, Butomus and a few others. The degree of stickiness and the percentage of PMC's showing sticky behaviour was observed to vary from population to population in a species and also from species to species in the same genus. Such stickiness of chromosomes does not interfere much with the meiotic course in majority of the PMC's in Aliinaraceae and Orchidaceae. In PMC besides laggards or fragments or a bridge at A_I, similar features were also seen at A_II in Allium schoenoprasum.

Genetically controlled stickiness was first reported in Zea mays (Beadle, 1932) and was due to a recessive gene, Martini and Bozzini (1956) in Triticeum species and Mehra
N. C. and Rai (1972) in *Collinesia tinctoria* attributed the sticky behavior to a single recessive gene. Inbred lines of *Alonecurus myosuroides* (Johnson, 1944) and of *Capsicum* (Sneyd, 1966) also showed stickiness. Inbreeding may have resulted in homozygosity for a recessive gene causing this abnormality.

Stickiness may be associated with some meiotic aberrations too i.e., asynapsis or desynapsis in *Capsicum* (Morgan, 1963), and with the formation of binucleate cells in *Avena* hybrids (Holden and Sata, 1956). Presently stickiness associated with asynapsis or desynapsis was noticed in *Allium porrum* (2n=32), *Allium tuberosum* and *Lilae* spp.

It may be recalled that the following points have been discussed separately in the discussion of individual families.

1. Chiasmata frequency.
2. Types of chiasmata, their localisation or non-localisation.
3. Achromatic bivalents.
4. Failure of multivalents to orient themselves on to the equatorial metaphase plate.

It has been observed that with the increase in the size of chromosomes there is proportionate increase in the chiasma frequency and that the long-sized chromosomes have localised chiasmata. *Allium polyphyllum* and species of *Allium* which have large chromosomes, have higher number of
chiasmata per bivalent while *Kniphofia uvaria*, *Eremurus himalaicus* which have medium-sized chromosomes have lower number of chiasmata per bivalent, and *Iris ensata*, *Sparganium filicinum* having small-sized chromosomes have lowest number of chiasmata per bivalent. A chiasmatic tendency in bivalents of some plants like *Allium Jacquemontii*, *Iris ensata* suggests their hybrid nature. Failure of congression multivalents on equatorial M₁ plates have been observed in some tetraploids i.e. *Allium tuberosum*, *A. porrum*.

Structural Hybridity

Structural hybridity of a greater or lesser degree has been presently observed in *Allium porrum* (2n=32), *A. tuberosum*, *Iris ensata* and *Tradescantia canaliculata*. This may be due to translocations, inversions, duplications and deletions. A bridge-like structure indicates a paracentric inversion, which was commonly observed in *Tradescantia canaliculata*, *Allium griffithianum* and *Eremurus himalaicus*.

Secondary Associations

Kuwada (1969) was the first to report secondary associations in *Oryza sativa*. Since then these have been noticed in a wide range of species. Mehra and Bawa (1970), and Mehra and Vij (1972b) reported their occurrence in many orchid species. In the present investigations secondary associations were seen in *Kniphofia uvaria*, *Iris ensata*, *Nemerosella fulva*, *Allium schoenoprasum*. Lawrence (1931)
reported secondary associations to be widely occurring in polyploids.

Various workers have attributed such associations to different causes. Ailey (1960) ascribed them to residual homology in *Iriticum sestivum*. Kobayashi (1952) thought unfavourable temperature and habitat to be the cause. Thomas and Reevell (1946) ascribed them to the tendency of heterochromatic regions of different chromosomes to associate with one another in *Cicer arietinum*. Eftimiu-Heim (1943) attributed these to the presence of mycorrhizal fungus in orchids. Brown (1935) considered secondary associations as an artifact. Considerably varied opinions exist regarding the causes and cytological and genetical consequences of secondary association in a species.

Laggards and Bridges

Laggards at $A_1$ as observed in *Iris ensata*. Polygonatum verticillatum may be due either to their polyploid nature or hybridity. Abnormalities in *Hemerocallis fulva* may be due to its triploid nature. Laggards in *Hosta* may be due to heterozygosis in chromosomes and their noncongregation at the equatorial plate. The cause of unequal distribution of chromatin in diploids i.e. *Fremurus himalaiicus* is not clear but in some tetraploid *Allium* it may be due to desynapsis. Bridges along with fragments and sometimes laggards as observed in *Allium griffithianum* and *Tradescantia constricta* may be due to their tetraploid nature and heterozygosity gained after translocation.
Desynapsis

Frakken (1943) found three types of desynapsis: weak, medium-strong and complete. Presently complete desynapsis was found in *Allium porrum* (2n=32), medium-strong desynapsis in *Allium tuberosum* and species of *Iris* and weak desynapsis in *Allium astrachyni*, *Kniphofia viva* and *Tradescantia columbia*. Li et al. (1943), attributed desynapsis in wheat at or after pachytene to the presence of a recessive gene "de", which they inferred arose from spontaneous mutations. The precise mode of action of the gene is not fully understood. Earlier desynapsis in different plants have been reported by various workers in *Datura*, *Rheum*, *Alpoeurus*, *Iris*, *Allium* (cf. Kohli and Koul, 1971).

Present investigations revealed that desynapsis is also accompanied with noncondensation of chromosomes at $A_1$ and $A_1$ in most of the PPC's in *A. porrum* (2n=32) resulting in an irregular distribution of chromosomes, occurrence of laggards and other abnormalities. In such cases pollen fertility is reduced. Such plants mostly adapt themselves to a vegetative mode of propagation.

POLYPLOIDY

Perusal of literature reveals that some families are characterised by a high frequency of polyploidy, there are others which are nearly or totally devoid of it. Highest percentage of polyploids are found in families containing perennial herbs or shrubs, a smaller proportion in those
with annuals and the lowest percentage in families which constitute woody plants. Polyploidy is a common method of evolution in higher plants.

Out of a total of 68 taxa presently investigated 41 are diploids, 27 are polyploids. The frequency of polyploidy, thus, comes to 40.11%. This high percentage is to be expected since the incidence of vegetative reproduction has also had its part to play in the spread of polyploids. Polyploids have more survival value if they possess potentialities for an effective mode of vegetative reproduction.

A perusal of the literature reveals that among the families investigated, majority of the members of Iridaceae are at polyploid level. In Iridaceae polyploidy is highly developed in *Polystachya*, *Tulipa*, *Hemerocallis*, *Muscari*, *Campanula* but is infrequent in *Eremurus*, *Fritillaria*, *Lilium*, *Kniphofia* and *Hyacinthus*. An intermediate situation is found in *Hosta*. In *Allium* polyploidy is highly developed. Among Alismataceae, it is frequent in *Alisma* and infrequent in *Spitellaria*. Polyploidy is also common in *Butomus* of Butomaceae, *Tradescantia* of Commelinaceae, *Arisaema* of Araceae and in *Monochoria* of Pontederiaceae. At the intraspecific level there is a report of only a triploid form in *Hydrilla verticillata* but there is no certainty about the existence of the polyploids in *Hydrocharis dubyi*, *Orodea* of Orchidaceae possesses diploid and tetraploid taxa in *Dactylolabia*. The nature and origin of ploidy at specific and generic levels,
whether allo- or auto-, has been dealt with in discussion parts of individual families.

Darlington (1937) stated that with polyploidy chromosome number multiplies but without a proportionate increase in the area of metaphase plate with the result that nucleocytoplasm ratio is disturbed. Menra (1967) postulated that there is always an optimum in the number of genomes (chromosome sets) which can operate successfully within the cytoplasm in every individual species. In some cases this optimum may reach at the diploid level, in others at a higher level but there is always an upper limit to it. A special method of chromosome doubling by means of transverse breakage of chromosomes was suggested by Malevsky and Garde (1951) for members of the family Cyperaceae with diffused centromeres. They designated it as "agmatoploidy" (fragment ploidy). According to Utzén (1962) these agmatoploids cannot always be arranged in normal polyploid series for the breakage may be confined to only a part of the genome.

Polyploidy is a very common method of evolution in higher plants. Nevertheless, it has contributed little to progressive evolution, in genera which contain both diploids and polyploids, the major trends of evolution are all represented by diploid species, and the polyploids serve merely to multiply the variation on certain particular adaptive "themes" (Stebbins, 1962). This is probably because large amount of gene duplication dilutes the effects
of new mutations and gene combinations to such an extent that polyploids have great difficulty in evolving truly new adaptive gene complexes.

Polyploidy is a very striking phenomenon in higher plants and studies of polyploids can provide much information about the past history of plant groups. This is because it is one of the very few evolutionary trends of which the direction can be clearly determined without fossil evidence.

Distribution of Chromosome Races

Different chromosome races of a species can occupy some or adjacent habitats as in Polycnatast verticillatum, or may form well established distinct colonies as in Autopolis umbellatus. de et al (1971) suggested that the gene exchange also takes place "through continuous formation of new polyploids or by means of fertilisation of the tetraploid by diploid pollen produced by the diploid populations".

Polyploids, in general, have been found to display wider ranges of tolerance to extreme climatic and edaphic conditions because of buffering effect of multiple genomes.

ANEUPLOIDY

The role of aneuploidy in the presently investigated taxa both at specific and generic levels has been dealt with in the discussion parts of individual families. However, of the 35 genera presently studied, 12 genera possess one base number, and 18 have more than one base number.
Interspecific aneuploidy has been observed in the genus *Alisma* which presumably has happened by the fragmentation of some chromosomes at the centromeric region. In such aneuploidy, there does not seem to be any loss of chromatin material. Intraspecific aneuploidy has been observed in *Polyconatum multiflorum* (2n=22, 28) where the total chromatin length of 2n=22 is equal to that of 2n=28.

The occurrence of more than one base number in majority of the monocotyledonous genera points to their cytological instability. Stebbins (1938) has attributed this instability to the varied growth forms in herbaceous genera many of which show changes in chromosome number and size, in contrast to one type of growth form in woody species which are cytologically very stable.

Different authors have different opinions regarding the causes leading to aneuploidy. Tuschanjakove (1929) suggested non-disjunction to be the cause. According to Richardson (1933) and Mac Mohan (1936) aneuploidy is due to fragmentation. Heijer (1952) opined that aneuploidy results from the partial return to the basic number by the progeny of a triploid. Present observations are in support of the fragmentation of chromosomes followed by recombination leading to a condition found in *Polyconatum multiflorum* where the total chromatin length in the two cytotypes is unaltered. Somewhat similar situation is noticeable in *Alisma lanceolatum*.

One point fairly well brought during the present studies is the rarity of aneuploids in most of the taxa studied.
Aneuploidy is less common than polyplidcy because it may produce a state of imbalance in many cases due to a few additional chromosomes in contrast to a complete set.

**CHROMOSOME MOSAICS**

Variable chromosome numbers occurring in the same tissue along with the full complement were termed "Chromosome mosaics" by Frankhauser (1945). Such mosaics occur in many angiosperma families and are found to be common in hybrids. Variable chromosome numbers have been recorded in intraspecific hybrids of *Festuca arundinacea* by Malik and Thomas (1966), in *Sesbania toosendai* x *Vanda merrellii* and other intergeneric hybrids by Kamemoto and Shindo (1962), in *Vanda* hybrids by Kamemoto (1955) and Kamemoto and Tanaka (1960), in many *Dendrobium* hybrids (Tanaka and Kamemoto 1972, 1974). The same situation has been recorded in polyploids and amphidiploids of *Iriticum*, *Aegilops*, and *Aegropoa* (Sachs, 1952), in *Sesalia* by Rees and Thompson (1955), in tetraploid garden roses by Shah and Shastry (1963). Chromosome numbers varying from n=16-21 were reported in a monosomic line of *Iriticum aestivum* by Chopra (1960). Similarly chromosome mosaics have been reported in *Datura* by Bhaduri and Sharma (1946), in a collection of *Paspalum pacerioides* by Gupta and Srivastava (1972), in *Saccharum spontaneum* by Kehra and Sood (1974). Many orchid species are also known to have PMC's with variable chromosome numbers (Tanaka and Kamemoto, 1972, 1974).

Presently in *Hosta* species such variable numbers were
observed in some PMC's and same situation was found in Allium tuberosum. Rees (1955) considered premeliotic mitotic irregularities or spindle abnormalities (Vaarama, 1949; Parthasarathy, 1951; Alexander, 1955, 1956) to be responsible for aneuploid or polyploid numbers in the PMC's of the same anther.

There are reports of chromosome mosaics in the somatic tissues too e.g., in Rubus by Britton and Hill (1937), in Saccharum officinarum by Jagathesan and Ratnambal (1967), in Uncidiurn stenotis by Chardard (1963), in a number of members of Amaryllidaceae by Khoshoo and Raina (1971). Presently variations of the chromosome numbers in the cells of the same root-tip were observed in Separaque filicinum and Hosta Plantaginea.

Such mitotic instability resulting in aneumotic variation in plants, if followed by the widespread mode of vegetative propagation as in most of the bulbous or rhizomatous plants, could lead to the formation of plants with different chromosome numbers. Mosaicism in meiotic cells could lead to the formation of the gametes of variable constitution which, if successful in fertilisation, would result in aneuploids (cf. Mehra and Sood, 1974).

B-CHROMOSOMES

The present study on 62 species with 68 taxa of monocots has revealed the occurrence of B-chromosomes in only a few
species namely, Allium stracheyi, Tradescantia canaliculata, Hosta plantaginea, Trillium covanianum and Asparagus filicinus. The size of **E-chromosomes** in Allium stracheyi, Tradescantia canaliculata and Trillium covanianum is much smaller than of A-chromosomes. But in Hosta plantaginea and Asparagus filicinus, B-chromosomes can sometimes be misinterpreted because of their comparable size with A-chromosomes.

B-chromosome was for the first time detected by Longley (1927) in *Zea mays*. Since then it has been found that the occurrence of B-chromosomes in angiosperms is widespread (Battaglia, 1964) and is especially high in annual diploid flowering plants (Darlington, 1973). Mehra and Kalia (1973) suggested that distinction be drawn between accessory chromosomes and B-chromosomes. They suggested that "accessory chromosomes be designated those which are additional to the normal set and cannot be morphologically distinguished from them. B-chromosomes be designated those that are smaller in size and usually heterochromatic in nature." B-chromosomes are ordinarily distinguished from A-chromosomes by two properties. Firstly the B's are usually small in size. Secondly they may be present in one organ and absent in the other of the same individual and do not necessarily pair with one another at meiosis. Pairing, when it occurs among B's is due to homology of some kind or stickiness (Mehra and Kalia, 1973). Association of B's with A-chromosomes is indicative of similarity of parts and may suggest their recent origin. Kaushal and Mehra (1976) adduced evidences to show...
how B-chromosomes are derived from A-chromosomes in *Pterotheca falconeri*. B-chromosomes may not be entirely inert as formerly conceived but they may also be useful. Not indiscriminately useful perhaps but useful in some special sense. Darlington (1936) stated that B-chromosomes add to the variability of species.

KARYOMORPHOTYPES, CYTOTYPES AND THEIR TAXONOMIC STATUS

The phenomenon of occurrence of variation in the karyotypes of different populations of a species and of more than one cytological types within a species is fairly widespread in Monocots.

The karyological variations among the various populations of *Iris longifolia*, *Allium victorialis*, *A. schoenoprasum*, *Eremurus himalaicus*, *Hydrilla verticillata* and *Hydrocharis dubia* have been discussed separately in the discussion of their respective families. Differences in karyotypes may be sometimes accompanied with some minor morphological variations but these are not considered enough to separate them from each other even at the varietal level.

Intraspecific races have been observed in *Autonurus umbellatus* (2n=28, 39), *Allium paradoxum* (2n=32, 48) *Polygalaum multiflorum* (2n=22, 28), *Polygalaum verticillatum* (2n=30, 60), *Iris ensata* (2n=40, 60) and *Urginea latifolia* (2n=40, 80). In these taxa, though the chromosome differences are associated with certain morphological differences, yet the occurrence of intermediary forms exist in nature, making it impracticable
to differentiate the various cytotypes of the species in the
field on the basis of these differences.

Much controversy exists as to whether the different
taxa of a species with different chromosome numbers,
irrespective of the magnitude of morphological differences, be
raised to the level of subspecies or even distinct species.
In *Allium porrum* visible morphological differences occur
in the two cytotypes and can be regarded as two varieties
*Allium porrum* var. *porrum*, a tetraploid and *A. porrum* var.
great headed garlic hexaploid.

Löve and Löve (1961) advocate that all taxa in which
related forms differ in chromosome number be regarded as
distinct species. According to Smith, however, chromosome
number alone could not be taken as the sole criterion for
taxonomic segregations. Davis and Heywood (1963) too have
expressed their disapproval of regarding the diploid and
polyploid forms in a species as distinct species unaccompanied
by clear cut morphological differences. Numerous instances
of morphologically indistinguishable polyploids are available
in literature (cf. Darlington, 1937; Larsen, 1963). Mehra and
Ramanandan (1973) opined that numerous chromosomal changes
like polyploidy, aneuploidy and structural changes are
exhibited in diverse species, many of which are eliminated
during sex cell formation in the form of high pollen sterility.
But such abnormal genotypes have a chance of limited
propagation and survive through multiplication by vegetative
means in case they are physiologically balanced in relation
to the environments. Such fluctuations in chromosome numbers are especially rampant in certain genera and species which have an agamospermic mode of reproduction. Mehra and Sood (1974) found a large number of different cytotypes in *Sesbania spontanea* which exhibited intraspecific variations due to both numerical as well as structural chromosomal alterations, but the variations were not considered sufficient to accord the different cytotypes the status of a species or subspecies.

Cytotypes may show some distinction in their stomatal and pollen size, otherwise in the field they may be morphologically indistinguishable. Bocher (1960, vide Davis and Heywood, 1963) described the fallibility of taking pollen size as an indicator of polyploidy. He observed that in *Campanula rotundifolia* the pollen size of diploid taxa may attain the same dimensions as those of tetraploids. Thus advantages, if any, of following the procedure of naming polyploid forms as different subspecies or species are soon lost by the resulting confusion. Of course in different geographical regions the isolated different populations if otherwise cytologically different may merit a varietal rank.

Some highlights of the present work

Population studies have revealed some interesting cytological features which may be enumerated as follows:

1. Using identical techniques it has been brought to light that the karyotypes in different populations of a species
may be similar in respect of the number and morphology of their chromosomes but the size of the karyotype as a whole may be variable. This has been verified in a number of preparations (cf. *Hydrocharis verticillata*, *Hydrocharis dubia* *Allium schoenoprasum*, *A. victoriae*).

II. While chromosome number in different populations of a species may remain the same, there are differences in the morphology of their chromosomes (cf. *Ermerurus himalaeus*, *Trillium ovatum*).

III. Both the number as well as morphology of the chromosomes may be different so that the karyotypes as a whole differ in different populations of a species (cf. *Polygnotum multiflorum*, *P. verticillatum*, *Allium corrum*).

It may be stated that in all these cases there were no sharp qualitative morphological differences in the different populations of a species.

Fragmentation of chromosomes at the centromeric region as well as compounding of chromosomes has been at least one of the modes of speciation amongst the members of Alliaceae—the most primitive family of Monocots.

From cytotoxonomic viewpoint the following conclusions have emerged.

I. *Allium consanguinum* and *A. stracheyi* which have been regarded by some taxonomists as distinct species and by others as synonymous seem to be different taxa on the basis of karyotypic studies.
II. *Allium blandum* and *A. thomsoni* which are both considered as synonymous with *A. carolinianum* deserves separate specific identity on the basis of their karyotypes.

III. *Tulipa stellata* and *T. clusiana* possess different karyotypic configurations supporting their status as separate species as regarded by some taxonomists.

IV. *Allium porrum* 4x and 6x are not morphologically identical. Their karyotypic analysis has revealed that the latter has qualitatively different basic chromosome sets compared to the former. Hence in the author's opinion 6x taxon deserves a distinct varietal status.