OBSERVATIONS

FAMILY: BUTOMACEAE Rich.

According to Lawrence (1951) the family comprises 6 genera and 9 species. Pichon (1946) had transferred 5 genera to Alismataceae and retained one genus *Butomus* under the family Butomaceae. According to Airy Shaw (1973) the family is unigeneric.

*Butomus* L.

A monotypic genus distributed in the temperate regions, sometimes included under Alismataceae from which it differs by the absence of latex, leaf-shape, inflorescence, introrse anthers, numerous scattered ovules, and straight embryo.

*Butomus umbellatus* L.

Highly polymorphic species whose several forms are recognised specifically and intra-specifically. It is widely distributed in Kashmir valley at an altitude of 1500-2100 m. Found also as a weed in the paddy fields. The leaves are used locally in making mats and baskets.

Two different cytological races with 2n=26 (Fig. 2) and 2n=39 (Fig. 3) were observed.

Meiosis of the cytotype having 2n=26 showed stickiness at diakinesis (Fig. 4).
Seed tip mitosis revealed 2n=26 (Fig. 2), which fall into 13 pairs (Fig. 3). Karyotype consists of 2m+2m+8st+14t chromosomes falling into four size categories H, I, J and K. Karyogram shows wide variation in chromosome size (Fig. 3). Total chromatin length is 66.17 μ and TP% is 16.46. Chromosome size ranges from 3.73 to 1.21 μ and 5% is 21.15. Detailed karyotypic formula is 4st+2 I8m+2 It+2J8m+4Kst+12Kt.

The chromosomes of other cytotype with 2n=39 (Fig. 5) fall into 13 groups (Fig. 6), each consisting of 3 chromosomes. Chromosomes of the groups 1 and 3 are not all identical and exhibit differences in respect to the arm ratio and chromosome length. Karyotype consists of 3m+13st+21t chromosomes, falling into four size categories, d, l, j and k. Total chromatin length is 86.86 μ and TP% is 14.03. Chromosome size ranges from 4.96 to 1.17 μ and 5% is 23.70. Detailed karyotypic formula is 3m8t+3 It+3 J8t+3 K8t+12Kt.

Morphological variation in the two cytotypes are depicted in the Table II and Fig. 7.

**DISCUSSION**

The present count for *Butomus umbellatus* 2n=26 confirms the reports of some previous workers (cf. Table I), but is at variance with others who observed 2n=16, 20, 22, 24, 26, 40, 42 (cf. Table I). The karyotype of *Butomus umbellatus* is almost the same with little difference drawn
<table>
<thead>
<tr>
<th>Characters</th>
<th>2n=20</th>
<th>2n=39</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaf:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>length</td>
<td>30–50 cm</td>
<td>60–90 cm</td>
</tr>
<tr>
<td>breadth</td>
<td>0.3–0.5 cm</td>
<td>0.6–1.3 cm</td>
</tr>
<tr>
<td><strong>Peduncle length</strong></td>
<td>30–65 cm</td>
<td>70–100 cm</td>
</tr>
<tr>
<td>Number of flowers per peduncle</td>
<td>12–20</td>
<td>15–25</td>
</tr>
<tr>
<td>Pedicel length</td>
<td>3–7 cm</td>
<td>9–13 cm</td>
</tr>
<tr>
<td>Pollen size</td>
<td>28 x 26 μ</td>
<td>30 x 27 μ</td>
</tr>
</tbody>
</table>
It is interesting that a triploid with \(2n=39\) is met in Kashmir, but it grows separately and not intermixed with the diploid. Morphological variations between the two are distinct (cf. Table II, Fig.7). Triploid has large size compared to the diploid. The triploid seems to have been evolved by the fusion of diploid gametes with a haploid one since the two chromosomes of each group of the karyogram are more or less similar compared to the third one. Løve and Løve (1948, 1961) recorded intraspecific polyploidy in the species. Considering the earlier literature too, it appears that both aneuploidy and polyploidy at intraspecific level have played a role in the evolution of various morphotypes. Present report confirms the basic number \(x=13\) (Darlington and Wylie, 1935) for this genus.

FAMILY: HYDROCHARITACEAE Juss.

This family consists of 16 genera and 80 species (Airy Shaw, 1973), indigenous primarily to waters of the warmer regions of the world. The family is closely related to Butomaceae (Hutchinson, 1959). Dandy (cf. Hutchinson, 1959)
has divided this family into three subfamilies
(1) Vallisnerioidae or Hydrocharitoidae (II) Thalassioidae
and (III) Halophiloideae. Only a few members of the
subfamily Vallisnerioidae are found in Kashmir.

**Hydrilla** Rich.

Ayry Shaw (1973) reported only 1 species in this genus
distributed in Euroasian area and Algeria to Australia.

**N. verticillata** L.

The plant is submerged.

Karyotypic analysis of the various populations of
different lakes revealed 2n=16 (Figs. 8, 10, 12). Three
distinct karyotypes were noticed.

Karyotype of Dal lake population (Fig. 8), consists
of 4n+8sm+4st chromosomes (Fig. 9) falling into three size
categories A, I and J. Total chromatin length is 79.14 μ
and IF% is 37.83. Chromosome size ranges from 6 to 1.95 μ
and S% is 32.30. Detailed karyotypic formula is 4n=8sm+2sm+4st+
21st+4mj+4jmj.

Karyotype of Mansbal lake population (Figs. 10, 11)
consists of 4n+8sm+4st chromosomes falling into three size
categories A, I and J. Total chromatin length is 62.94 μ
and IF% is 37.60. Chromosome size ranges from 5.66 to 2 μ
and S% is 35.33. Detailed karyotypic formula is 4n=8sm+2sm+4st+
41sm+21st+4j mj.

Karyotype of Anchar lake population (Figs. 12, 13)
consists of 4n+8sm+4st chromosomes falling into four size
categories G, H, I and J. Total chromatin length is 68.61 μ and TPE is 30.43. Chromosome size ranges from 6.1 to 1.91 μ and S% is 31.31. Detailed karyotypic formula is 4Gsm+26st+44sm+21st+4Jm.

**Hydrocharis L.**

The genus comprises 6 species found in Europe, Mediterranean, tropical Africa, Asia, temperate Australia (Airy Shaw, 1973). Only one species is found in Kashmir.

**Hydrocharis dubia** (Bl.) Backer

This grows in lakes.

Karyotypic studies have been made of two populations, one of Dal lake and another of Anchar lake. Root-tip mitosis in both revealed 2n=16 (Figs. 14, 16).

Karyotype of Dal lake population (Figs. 14, 15) consists of 6m+2sm+8st chromosomes falling into four size categories H, I, J and K. Total chromatin length is 51.47 μ and TPE is 30. Chromosome size ranges from 4.70 to 1.91 μ and S% is 40.63. Detailed karyotypic formula is 4Hsm+21sm+4 1st+2Jm+21st+2Kst.

Karyotype of Anchar lake (Figs. 16, 17) consists of 6m+2sm+8st chromosomes falling into four size categories H, I, J and K. Total chromatin length is 36.17 μ and TPE is 32.46. Chromosome size ranges from 3.36 to 1.91 μ and S% is 35.63. Detailed karyotypic formula is 4Hsm+6 1st+2Jm+21st+2Ksm.
DISCUSSION

Presently 6 populations of *Hydrilla verticillata* and two populations of *Hydrocharis dubia* have been karyologically worked out. In both the species constant somatic chromosome number is 2n=16. Present count of 2n=16 for *Hydrilla verticillata* confirms the reports of a few workers (cf. Table I). Some other workers found a triploid cytotype with 2n=24 (cf. Table I).

The count of 2n=16 for *Hydrocharis dubia* is at variance with the findings of Shazma and Chatterjee (1967) who observed 2n=22. The present report is not in conformity with that of Fedorov and Day (1972) who observed 2n=14 for *H. morus fanae* collected from Kashmir which Stewart (1972) considers to be synonym of *H. dubia*. Furthermore 2n=14, 2b has been reported in *H. morus fanae* by Skalinska et al. (1951). *Hydrocharis asiatica* is the only species of the genus in which Harada (1936) reported 2n=16. But Sakolovskaia (1956, cf. Fedorov, 1969) reported 2n=14 for this species. Details of karyotypes of the two populations show dissimilarities with respect to their centromeric position, total chromatin length, 1F% and 5%.

Three of the six populations of *Hydrilla verticillata* from the different lakes exhibited the same karyotype, but with some difference in the size of the chromosomes of complement. The same holds somewhat good for the two populations of *Hydrocharis dubia*. Could the difference be
due to diminution in chromatin or variation in condensation as a result of environmental conditions.

The karyotypes of *Hydilla verticillata* and *Hydrocharis dubia* show broad similarities.

**FAMILY: ALISMATACEAE Vent.**

According to Lawrence (1931) the family comprises 14 genera and 55-60 species, distributed widely but mainly in the temperate and tropical regions of the northern hemisphere. Plants grow mostly in fresh-water swamps and streams. Airy Shaw (1973) estimated 13 genera and 50 species in the family. Hooker (1894) divided the family into two tribes, Alismae and Butomaeae, on the basis of nature of fruit. In the former the fruit is of 3 or more achenes, while in the latter it is always of follicles. Picton (1946) proposed that Alismataceae be treated as constituting members having lactiferous ducts, leaves petiolate with expanded blades, petals mostly caducous, ovules campylotropous, and seeds with curved embryos. This emendation resulted in transferring to Alismataceae all members of the Butomaceae except *Butomus*.

Phylogenetically it represents one of the most primitive of the extant monocot families.

**Alisma L.**

The genus comprises 10 species, which are cosmopolitan in distribution (Airy Shaw, 1973). The plants are sometimes
grown as ornamentals. Three species have been worked out presently.

**A. plantago-aquatica** Linn.

Common in ditches, ponds and along borders of rice fields in Kashmir.

Root powder is used as a cure for hydrophobia. Fresh leaves are used in homeopathy.

PMC's revealed n=7 at $M_I$ (Fig. 18). The smallest bivalent usually disjuncted early. Chiasmata number per bivalent was 2.1. All the three types of chiasmata $D$, $P$ and $M$ were noticed. Sticky bridges were seen at $A_I$, but ultimately all the 7 chromosomes reached at each pole at $A_I$ (Fig. 19). Pollen fertility was 93%.

Root-tip cells revealed $2n=14$ (Fig. 20). Karyotype consists of $4M+6m+4I$ chromosomes falling into five size categories $E$, $G$, $R$, $I$ and $J$ (Fig. 21). Total chromatin length is 83.14 μ and $TP_{%}$ is 39.37. Chromosome size ranges from 8.89 to 2.94 μ and $S_{%}$ is 33.03. Detailed karyotypic formula is $2F_{m}+4G_{m}+2R_{m}+2I_{m}+2I_{I}+2J_{I}$.

**A. craminus** Loj.

This species approaches **A. lanceolatum** and **A. plantago-aquatica** in leaf-shape, but differs from the two in having anthers suborbicular or isodiamic. Style is recurved, shorter than the ovaries. The species is rare in Kashmir.

PMC's revealed 7 bivalents at $M_I$ (Fig. 22) followed by a normal anaphasic distribution (Fig. 23). Chromosomes
showed stickiness. Pollen fertility was 100%.

Root-tip mitosis revealed 2n=14 (Fig. 24). Karyotype consists of 6 M+4 m+4 I chromosomes falling into five size categories F, G, H, I and J (Fig. 23). Chromosomes of the first pair of karyogram (Fig. 23) are asymmetrical with respect to arm ratio and chromosome length. Total chromatin length is 84.19 µ and TFr is 39.12. Chromosome size ranges from 9.14 to 2.94 µ and S% is 32.23. Detailed karyotypic formula is 2F^m+4G^m+4H^m+2I^m+2J.

A. lanceolatum wilt.

This species is found throughout the valley.

PMC's revealed 13 bivalents at M1 (Fig. 25). The smallest pair showed late disjunction (Fig. 27). Bridges and laggards were common. Pollen fertility was 92%.

Root-tip cells revealed 26 chromosomes (Fig. 26) which could be arranged into 13 pairs (Fig. 29). Karyotype consists of 12M+10m+2I chromosomes, falling into five size categories C, D, E, F and G. Twelfth pair possesses a satellite on its short arm (Fig. 29). Total chromatin length is 195.32 µ and TFr is 42.46. Chromosome size ranges from 10.29 to 3.99 µ and S% is 37.86. Detailed karyotypic formula is 2F^m+6G^m+2E^m+4C^m+4F^m+4H^m+2I^m+2J.

Sachteria L.

The genus comprises 20 species which are cosmopolitan in distribution (Airy Shaw, 1973). Two species occur in the western Himalayas.
S. sagittifolia L.

This water plant bears leaves of sagittate (arrow-shaped) type. It grows commonly in Kashmir. In the leaf-sheaths are formed short branches or the renewal shoots which burrow into the mud and perennate during the winter. These swell up at the ends to form tubers which contain starch and sugars. In Kashmiri they are called "Guv" and are eaten after frying by people of country-side. The species is of great medicinal importance as it is used in China to induce the flow of lochia, retention of placenta and in skin diseases (Kirtikar and Basu, 1933). Sometimes grown as an ornamental.

Chromosome number was determined both from PMC's and root-tips. PMC's revealed 11 bivalents at $A_1$ (Fig. 30). Chiasmata were of non-localised type and numbered two per bivalent. Pollen fertility was 97%.

Root-tip mitosis revealed $2n=22$ (Fig. 31). The karyotype consists of $2^{m}+2^{m}+18^{s}$ chromosomes falling into four size categories E, C, H and I (Fig. 32). Total chromatin length is 123.94 $\mu$ and $1F_2$ is 13.42. Chromosome size ranges from 19.26 to 3.06 $\mu$ and $S_2$ is 39. Detailed karyotypic formula is $2^{m}+46^{s}+10^{H}+2^{I}+2^{I}m+2^{I}t$.

S. guayanensis Kunth

Rare in Kashmir.

PMC's revealed n=11 (Fig. 33) and bivalents showed general stickiness. Chromosome distribution at $A_{II}$ was normal (Fig. 34). Pollen fertility was 98%.

Root-tip mitosis revealed $2n=22$ (Fig. 35). Karyotype
consists of $2^{n+2m+16}+2$ chromosomes falling into four size categories F, H, I and J (Fig. 35). Total chromatin length is 101,02 μ and T/F is 12.95. Chromosome size ranges from 8.60 to 2.20 μ and S/F is 25.64. Detailed karyotypic formula is $2F^{2}+6(n^{2}+1) I^{1}+2 I^{2}+2 J^{m}$.

DISCUSSION

Five species, *A. linnaceo-aquatica* ($n=7$, $2n=14$), *A. gramineum* ($n=7$, $2n=14$), *A. lanceolatum* ($n=13$, $2n=26$), *Sagittaria sagittifolia* ($n=11$, $2n=22$) and *S. guayanensis* ($n=11$, $2n=22$) of the family Alismataceae have been worked out.

*A. linnaceo-aquatica*: Except Baquar and Askari (1970) who observed $n=6$ for *A. linnaceo-aquatica*, the present count is in agreement with the reports of earlier authors as mentioned in Table 1. Chromosome count of $2n=14$ for *A. gramineum* confirms the reports of earlier workers (cf. Table 1), but differs with that of Packer (1968) who reported $2n=16$ for *A. gramineum*

K.C. Gmel. Three common numbers $2n=24$, 26, 28 for *A. lanceolatum* have been reported by earlier workers (cf. Table 1). Only the cytotype with $2n=26$ was found in Kashmir. Aleksandrova (1967, cf. Fedorov, 1969) also reported $2n=14$ for *A. lanceolatum*. The basic number of the genus is 7 and the genus includes diploids, tetraploids, hexaploid species (Björkquist, 1967, 1968). Furthermore there is one aneuploid number $2n=26$ at the tetraploid level. Karyologically the genus seems rather uniform.
The karyotype of *A. plantago-aquatica* having 40, 6m and 41 chromosomes is at variance with the findings of Cleason (1941) who observed 2 median, 2 submedian and 10 subterminal chromosomes but resembles very much with the findings of Björkqvist (1968), except that there is no satellite in a chromosome pair in the present preparations. Karyograms of two diploid species *A. plantago-aquatica* and *A. oramineum* are similar. The two have slight differences in total chromatin length and TFs. Meiotically both of them behave similarly. Detailed karyotypic formulae vary. Morphological differences are not very distinct except for details of anther and style morphology. The occurrence of *A. oramineum* is rare in Kashmir. The two diploid species seem to have evolved from a common stock. During speciation, gene mutation may have played a role in changing the anther shape and style size.

*Aliga lanceolatum* (n=13, 2n=26), is at tetraploid level. Its karyotype has presumably evolved by the fusion of two terminal chromosomes 6, 7 (of diploids), forming an "m"-chromosome (i.e., chromosome 4 of *A. lanceolatum*). There is complete bivalent formation irrespective of its disomic tetraploid nature. From the total chromatin length data, no loss of any chromatic material seems to have occurred, as the half of *A. lanceolatum* exceeds the total chromatin length of diploid.

Among the members studied at present, the most primitive karyotype is represented by *A. plantago-aquatica*.
slightly advanced in *A. gramineum* and much advanced in
*A. lanceolatum*. It seems that karyotype of diploids (n=7)
has been derived from the progenitors with n=6 and the
chromosomes 6 and 7 have evolved after a break at the
centromere of a submedian chromosomes. Its ploidy level
has modified the leaf morphology.

_Sacitteria:_ Present count of n=11 and 2n=22 for _Sacitteria
schlittifolia_ confirms some previous reports (cf. Table I),
but is at variance with others (cf. Table I). Present
count of 2n=22 for _A. susyanensis_ confirms the previous
reports (cf. Table I). Both the species have similar
karyotypes, resembling the observations of Sharma and
Chatterjee (1967). The chromosome pairs 2-9 with terminal
centromere have probably been derived from _Alisma_ (n=7)
through fragmentation at centromeres of chromosome pairs
2, 3, 4, 5 which are m-chromosomes, thus giving rise to
chromosomes 2, 3, 4, 5, 6, 7, 8, 9 of _Sacitteria_. Chromosomes
of 1st pair of karyogram of _Sacitteria_ with median
constriction are comparable to chromosomes of 1st pair of
_Alisma_. 10th pair of _Sacitteria_ with telocentric condition
is comparable to 6th pair of _Alisma_. Eleventh pair of
_Sacitteria_ seems to be comparable to 7th pair of _Alisma_ only
after chromosomal repatterning, since there is no size
difference. The species have stabilized themselves at
diploid level with a consistent base number of 11.

Author believes that the original base number of
Alismataceae was \( n=5 \) and the complement consisted of all median - , submedian chromosomes. The number \( n=7 \) is the result of fragmentation of one of these at the centromere resulting in 2 terminal chromosomes. *Alisma lanceolatum* \((n=13, 2n=26)\) is a tetraploid in which only one median - , submedian chromosome has fragmented at the centromere. The genus *Samitaria* with \( n=11 \) owes its origin through fragmentation at the centromere region of all the chromosomes but one. The course of karyological evolution is graphically represented in Fig. 29a which is based on karyotypic analysis of the two genera.

*Alismataceae* being a very primitive family of Monocots, this perhaps implies that the original base number of monocots was 6 chromosomes, all with median - , submedian centromere.

**FAMILY : COMMELINACEAE R. Br.**

*Airy Shaw* (1973) reported 36 genera and 500 species in this family which is confined to tropical, subtropical and warm regions of the world.

*Tradescantia* L.

The genus comprises 60 species (*Airy Shaw, 1973*). Only one species has been worked out presently.

*I. canaliculata* Raf.

The species is cultivated in the gardens as an ornamental.
Meiotic studies showed quadrivalents, bivalents and univalents and in addition 4 B-chromosomes at M_I (Fig. 37). Quadrivalents commonly formed ring-like structures. Chiasma were of I-type. Fig. 36 shows chromosomes arranged on equatorial plate and early movement of B's towards poles. In most of the cells B's remain attached to A's (Fig. 38). Laggards were seen at I_1 (Fig. 40). A bridge and a laggard can be noticed at late I_1 in Fig. 41. Pollen fertility was 75%.

Root-tip mitosis revealed 2n=24+4B (Fig. 42). Karyotype consists of 4M+14m+6sm chromosomes and fall into 2 size categories D and E (Fig. 43). The chromosomes fall into six groups, each of four. The members of 5th group are not all identical probably because of small translocations due to heterozygosity. Total chromatin length is 298.60 μ and TF% is 41. Chromosome size ranges from 14.11 μ to 11.32 μ and 8% is 60.48. B-chromosomes are 1.12 μ long. Detailed karyotypic formula is 4D^m+4E^m+10E^s+6E^sm+4B's.

DISCUSSION

The count for Ixodescantia canaliculate confirms most of the previous reports (cf. Table 1), except for B-chromosomes. The latter were noticed consistently in both the root-tip cells and MMC's. The present taxon is an auto-tetraploid as evidenced by the karyogramic configuration and multivalent formation at meiosis.
Anderson and Sax (1936) observed intraspecific polyploidy (2n=12, 24) in this species. Other cases of intraspecific polyploidy in the genus are *I. bracteata* (2n=12, 18), *I. occidentalis* (2n=12, 24), *I. semicuieata* (2n=32, 48) (vide Darlington and Wylie, 1935 and Fedorov, 1969). Mitsukuri (1947) found 2n=24, 26 in *I. reflexa* indicating the occurrence of an aneuploid race. In *I. albiflora* 72 chromosomes have been reported (Anderson and Sax, 1936).

The plant is tropical but has acclimatised well in the temperate region, perhaps due to accessory chromosomes.

**FAMILY: LILIACEAE Juss.**

Liliaceae is one of the largest families of monocotyledons. It is believed to represent the basic stock from which have evolved the great majority of present day "petaloid monocot" families including such well-known representatives as the amaryllids, irises, palms, aroids and orchids. Hooker (1894) characterised the families Liliaceae and Amaryllidaceae with actinomorphic petaloid perianth and 6 stamens. The distinguishing basis for the two families was superior ovary in Liliaceae and inferior in Amaryllidaceae. Mendel (1933) is in complete agreement with Hooker (1894). The re-definition by Hutchinson (1934) of the Liliaceae and Amaryllidaceae on the basis of inflorescence character is probably more fundamental than that based on ovary position, the latter being a character that oscillates within several genera.
of these families between superior and inferior. The transfer of the Agapantheae, Alliceae and Lilieaeceae to the Amaryllidaceae has been accepted by some morphologists and anatomists (Cheadle, 1942) and is further supported by pollen studies (Maia, 1941). Its present adoption by many cytologists like Darlington and Wylie (1935) in their "Chromosome Atlas" seems certain to gain support following gradual disintegration of what may well be natural prejudice to change. These authors have followed Hutchinson (1934), except that they have retained the tribe Alliceae and Agapantheae in Lilieaeceae on account of their chromosome affinities. Fedorov (1969) and Moore (1973) have followed Hutchinson with some modifications.

Hooker (1894) divided the family into 16 tribes taking into consideration the habit, stem, leaf, flower, anther and ovule characters. Hutchinson (1939) has created 28 tribes in Lilieaeceae and stated that keying out of its tribes is a very difficult task as several of the characters overlap.

The family is comprised of about 187 genera and 2500 species according to Hooker (1894), 200 genera and 2000 species according to Kendie (1959), 175 genera and 2000 species according to Bailey (cf. Lawrence, 1931), 240 genera and 4000 species according to Lawrence (1931) and 290 genera embracing 3700 species according to Airy Shaw (1973).

Economically the lily family stands high owing to its importance as ornamentals. Tulips, autumn crocuses,
hyacinths, lilies, scillas and others constitute the bulk of the world's horticultural trade. *Hemerocallis* deserves special mention in this regard. *Asparagus* has commercial significance.


Out of the 22 tribes of Liliaceae (sensu Hutchinson, 1972), only 7 tribes have been studied presently. Alliums have been treated in a separate family Liliaceae.

**Tribe: Asphodeles**

Rootstock is in the form of a short rhizome, leaves in a basal cluster and inflorescence racemose or paniculate,
Only one genus *Eremurus* has been worked out at present.

*Eremurus* Bieb.

Ary Shaw (1973) estimates 10 species in this genus which are Oriental and North-Asian in distribution. Hooker (1894) reported 2 species occurring in Western Himalayas. Stewart (1972) mentions a single species from Kashmir.

*E. himalaicus* Baker

It grows wild in patches in the hills of Kashmir at 2100 - 3000 m and is also grown in gardens as an ornamental.

Detailed meiosis has shown that the number of nucleoli vary from 1-3 in different populations (Figs. 44-46). Various stages of diplotene and diakinesis were observed (Figs. 44-47). Uncondensed chromosome regions showed less synopsis (Fig. 47). Chiasmata were mostly localised and of all the three types - D, M and P (Fig. 48). They finally terminalise. An abnormal bridge-like structure at A is seen in Fig. 49. Occasionally 6:8 distribution of chromosomes occurred at A (Fig. 50). Pollen fertility was 98%.

Karyotype of the different populations is not identical but all showed 2n=14 (Figs. 51, 53, 55).

Karyotype of Meenamarg population (Figs. 51, 52) consists of 3m+1sm+1st chromosomes, falling into four size categories P, G, I and J. Total chromatin length is 99.8 μ and TFM is 24.48. Chromosome size ranges from 8.67 to 2.57 μ and S is 29.64. Detailed karyotypic formula is 6Fst+4Gst+1 Im+1 I sm+2 sm.
Karyotype of Srinagar population (Figs. 53, 54) consists of 2n=58m+2st chromosomes falling into three size categories E, F and G. Seventh pair possesses a satellite at the end of short arm (Fig. 54). Total chromatin length is 143.67 μ and T%= 33.16. Chromosome size ranges from 12.10 to 5.68 μ and S% is 46-59. Detailed karyotypic formula is 2Emt+8Em+2Fst+2Gm.

Karyotype of Pahalgam population (Figs. 55, 56) consists of 2n=58m+1 at chromosomes falling into four size categories C, D, E and G. Many of the pairs are heteromorphic. Fourth pair (Fig. 56) is quite asymmetrical both on the basis of arm ratio and length. Seventh pair is satellited at the end of short arm. Total chromatin length is 162.41 μ and T% is 35.36. Chromosome size ranges from 16.10 to 6.76 μ and S% is 41.96. Detailed karyotypic formula is 2Cstm+4Dsm+10Eft+3Gmt+2Etm+2Gm.

This species demonstrates unequivocally variation in karyotypes of different populations in regard to size and position of centromere in the corresponding chromosome pairs.

Tribe: Kniphofieae

Members are rhizomatous. Leaves radical, linear but not fleshy. Inflorescence is racemose or spicate. Perianth segments connivent into a straight or narrow tube.
*Kniphofia* Moench.

The genus comprises 75 species, distributed in eastern and southern Africa and Madagascar (Alry Shaw, 1973). Only one species has been worked out here.

*A. hybrida* L.

It is cultivated for its attractive showy flowers.

Chromosome study was done both from PMC's and root-tip cells. The number of nucleoli varied from 1 to 2 (Figs. 57, 58). At zygote pairing is complete after which there is the formation of a synaptic knot (Figs. 59-61). Diplotene and diakinesis revealed a tendency to desynapsis (Figs. 59-63). Interlocking of bivalents is seen in Fig. 61. The smallest bivalent was precocious in disjunction (Figs. 62, 63). A quadrivalent-like structure is seen in Fig. 63. Occasionally laggards were observed at A1 (Fig. 64).

Root-tip mitosis revealed 2n=12 (Fig. 65). Karyotype consists of 8sm+4st chromosomes, falling into three size categories D, E, and F. First and sixth pairs (Fig. 66) are heteromorphic. Total chromatin length is 131.02 μ and TF% is 28.27. Chromosome size ranges from 13.23 to 8.23 μ and S% is 62.2. Detailed karyotypic formula is 1D2sm+3E2sm+2E2st+1F2sm+3F2st.

**Tribe: Hemerocallidaceae**

The members of this tribe possess a rootstock which is either rhizomatous or bulb-like. Inflorescence panicle
or subcapitate, or if racemose the perianth-tube contracted in the lower part. Two genera, *Hemerocallis* and *Hosta* have been investigated.

**Hemerocallis** L.

The genus comprises 2® European and Asiatic species (Airy Shaw, 1973), most of which are cultivated as ornamentals. Only one species is grown in Kashmir for its showy flowers.

**H. fulva** L.

Meiosis was found to be highly irregular. Secondary associations of chromosomes were observed at A₁ (Fig.67), Bridges (Fig.69) and unequal distribution of chromosomes (Fig.68) was a common phenomenon at A₁.

Root-tip mitosis revealed 2n=33 chromosomes (Fig.70) which fall into 11 groups, each of three chromosomes (Fig.71). Karyotype consists of 18m+12m+3st chromosomes, falling into three size categories H, I and J. Total chromatin length is 133 μ and TP% is 34.94. Chromosome size ranges from 6 to 2.6 μ and 5% is 43.35. Detailed karyotypic formula is 6H+12I+12J+3star. The species is triploid.

**Hosta** Tratt.

According to Airy Shaw (1973) the genus consists of 10 species, distributed in China and Japan. Only two species are cultivated in Kashmir for ornamental purposes.

**H. plantaginea** Aschers.

At early diplotene 20 bivalents were seen (Fig.72). Small bivalents showed early disjunction (Fig.72). At A₁
some of the large bivalents exhibited delayed separation (Fig. 73). Pollen fertility was 98%.

Root-tip mitosis revealed 2n=50 chromosomes (Fig. 74) falling into 30 pairs (Fig. 75). There is a great disparity in the size of chromosomes. In some cells different numbers like 36 (Fig. 76) and 63 (Fig. 77) have been counted possibly because of aneusomaty as well as the occurrence of B-chromosomes which cannot be distinguished from small chromosomes of A category. Frequency of such cells is 3.5%. The karyotype consists of 13M+20m+6sm+6st+18t chromosomes, falling into five size categories, H, I, J, K and L. Total chromatin length is 107.5 μ and TF% is 22.43. Chromosome size ranges from 4.74 to 0.69 μ and SF% is 14.53.

Detailed karyotypic formula is 2Hst+2Ism+6It+2Jsm+4Km+18Km+2Kst+16Lm+2Lsm+2Lst+2Lt.

H. ventricosa Stearn

It is a common ornamental in gardens of Kashmir.

PMC's revealed n=30 (Fig. 78). Like in the previous species precocious disjunction occurred in the small bivalents (Fig. 78). In most of the PMC's subsequent stages of meiosis were normal. Pollen fertility was almost 100%.

Root-tip mitosis revealed 2n=50 chromosomes (Fig. 79) which fall into 30 pairs (Fig. 80). In this species too, there is great disparity in the size of large and small chromosomes. Karyotype consists of 8M+18m+6sm+14st+12t chromosomes, falling into five size categories H, I, J, K and L. Total chromatin length is 103.68 μ and TF% is 22.62.
Chromosome size ranges from 3.07 to 0.72 μ and 5% is 14.20. Detailed karyotypic formula is $4n^{s}t+4n^{t}+2I^{s}t+2I^{t}+2J^{s}t+$ $4J^{t}+14K^{m}+6L^{s}m+6L^{t}+8L^{m}+4L^{m}+2L^{s}m+2L^{t}$. It appears that in this genus disparity of chromosome size is perhaps indicative of fragmentation on a large scale.

**Tribe: Polygonateae**

The species falling in this tribe are rhizomatous, inflorescence axillary or paniculate. Anthers open by slits. Only one genus *Polygonatum* is worked out at present. *Polygonatum* Tourn.

According to Hooker (1894) the genus comprises 24 species which grow in the North temperate regions. Baker (1873) reported 23 species, while Hua (1892) described 53 species belonging to this genus. According to Aisy Shaw (1973) the genus is constituted of 50 species.

Roots of the species are emetic, cooling, antiperiodic, demulcent and are also used as tonic (Kirtikar and Basu, 1933). Only 2 species, out of 7 represented in Western Himalayas (Hooker, 1894), are found in Kashmir. *P. semeniferum* Deene

It grows in Kashmir hills at an altitude of about 2700 m.

Root-tip cells revealed $2n=30$ (Fig. 81). Karyotype consists of $4n+14m+12st$ chromosomes and fall into five size categories F, G, H, I and J (Fig. 82). Total chromatin
length is 139.44 μ and TF% is 31.22. Chromosome size ranges from 8.74 to 2.13 μ and S% is 24.37. Detailed karyotypic formula is $2^{2m}+6^{st}+6^{hm}t+2^{1m}+4$ $1^{m}+2^{2f}+6^{sm}$.

*P. multiflorum* All.

The species is widespread in Kashmir hills at an altitude 2200 m. Roots of the plant are employed as astringent, demulcent and tonic (Kirtikar and Basu, 1933).

The present study revealed two cytotypes. The taxa worked out from Sonamarg, Vernag and some other places mentioned in Table I showed $2n=22$ (Fig. 64), while that from Ahramal and Guimarg showed $2n=28$ (Fig. 66). Meiosis in the first cytotype revealed 11 bivalents at diplotene (Fig. 63) with an average of 2 chiasmata per bivalent. Pollen fertility was 99%. Its karyotype (Fig. 65) consists of $4^{m}+14^{sm}+4^{st}$ chromosomes, falling into four size categories F, G, H and I. Chromatin length is 129.5 μ and TF% is 29.0%. Chromosome size ranges from 8.23 to 3.06 μ and S% is 37.5. Detailed karyotypic formula is $2^{Fm}+2^{Gm}+2^{Hm}+2^{Im}+2^{Fm}+2^{Gm}+2^{Hm}+2^{Im}+6^{sm}$.

The cytotype with $2n=28$ (Fig. 66) consists of $2^{m}+8^{sm}+8^{sm}+18^{st}$ chromosomes falling into four size categories G, H, I and J (Fig. 67). Total chromatin length is 116.17 μ and TF% is 29.62. Chromosome size ranges from 6.39 to 2.06 μ and S% is 32.23. Detailed karyotypic formula is $2^{Gm}+2^{Hm}+6^{Hm}+4$ $1^{m}+6$ $1^{sm}+2^{Fm}+2^{Gm}+4^{sm}$.

Morphological differences in the two cytotypes are
pronounced as seen from Table III and Fig. 88.

P. verticillatum All.

Distributed in Kashmir hills at an altitude of 2000-3000 m. It exists in two cytotypes 2n=30 (Figs. 90, 92) and 2n=60 (Fig. 95). The latter was collected only from Ahrabal where it grows along with the cytotype 2n=30, but is giant-sized. The taxon 2n=30, shows the flexibility in the karyotype.

Populations of Ahrabal, Gulmarg area have the karyotype consisting of 4m+16s+10at chromosomes falling into five size categories F, G, H, I and J. Fourth pair of the karyogram (Fig. 91) is secondarily constricted. Total chromatin length is 129.33 μ and TFS is 31.48. Chromosome size ranges from 9.05 to 2.27 μ and S% is 23.76. Detailed karyotypic formula is 2F^M+4G^S+2H^S+6H^At+2I^M+4J^M+10J^M.

Karyotype of Zejila, Sonamarg, populations consists of 4m+16s+10at chromosomes, falling into five size categories F, G, H, I and J. Fourth pair of karyogram (Fig. 93) is secondarily constricted. Total chromatin length is 153.23 μ and TFS is 25.59. Chromosome size ranges from 9.77 to 2.35 μ and S% is 24.13. Detailed karyotypic formula is 2F^M+2G^S+6H^At+2I^M+2J^M+10J^M.

Taxon with 2n=60 (Fig. 95) has karyotype consisting of 16m+8s+16m+21at chromosomes falling into five size categories G, H, I, J and K, arranged into fifteen groups (Fig. 96), each group of four chromosomes. Total chromatin
<table>
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<td>breadth</td>
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<td>--------------------------------</td>
</tr>
<tr>
<td>Habit</td>
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<td>Shaded forest on slopes.</td>
</tr>
<tr>
<td>Plant height</td>
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<tr>
<td>Leaf:</td>
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<td>30x26 μ</td>
<td>39 x 41 μ</td>
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<td>whorled, 2-3 flid.</td>
<td>whorled, always 2 flid.</td>
</tr>
<tr>
<td>Pollen size</td>
<td>35x30 μ</td>
<td>41x36 μ</td>
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</table>
length is 196.77 μ and TF% is 30.04. Chromosome size
ranges from 7.35 to 1.02 μ and S% is 13.87. Detailed
karyotypic formula is 40M+4Sm+8St+41M+121St+8JSm+
16Kt+4KSt. Meiosis in this taxon was found to be erratic.
A number of laggards were seen at A1 (Fig.94). The taxon
appears to be an auto-tetraploid.

The morphological differences in the two cytotypes
are pronounced as seen from Table IV and Fig.89.

Tribe: Asparagineae

The plants are rhizomatous with erect stem and leaves
reduced to scales. The tribe is constituted by a single
genus.

Asparagus L.

According to Airy Shaw (1973) about 300 species are
distributed in Old World, Europe, temperate and tropical
Asia and Africa. Two species occur in Kashmir, whose roots
are used as tonic, astringent, diuretic and aperient
(Kirtikar and Basu, 1933). Only one species is worked out
at present.

A. filicinuS Ram.

Distributed throughout in Kashmir at 1500-2100 m.
Several populations have been studied, all have n=10 (Fig.97)
and 2n=20 (Figs. 98 and 100).

Srinagar populations revealed 10 bivalents with I-type
chiasmata at diakinesis (Fig.97). Subsequent divisions were
normal. Pollen fertility was 99%.

Root-tip cells showed 2n=20 (Fig. 98). Karyotype (Fig. 99) consists of 8m+12sm chromosomes, falling into three size categories, I, J and K. Chromosomes of the 1st pair are secondarily constricted in the long arms (Fig. 99). Second and eighth pair of karyogram are heteromorphic. Total chromatin length is 52.21 μ and Tm is 34.45%. Chromosome size ranges from 3.56 to 1.61 μ and 5k is 45.22. Detailed karyotypic formula is 6 I^m+6J^m+4J^sm+2J^m+2K^sm.

Some of the cells in the same root showed polysomy with double the number of chromosomes (Fig. 103). A few cells had small chromosomes which looked like B's (Fig. 102).

Karyotype of Harwan populations consists of 6m+14sm chromosomes (Figs. 100, 101), falling into three size categories I, J and K. Chromosomes of the 1st pair are secondarily constricted (Fig. 101). Total chromatin length is 52.59 μ and Tm is 33.58. Chromosome size ranges from 3.56 to 1.47 μ and 5k is 41.28. Detailed karyotypic formula is 2 I^m+6 I^sm+2J^m+8J^sm+2K^m.

The karyotypes are broadly similar in the two populations but with minor differences.
Tribe: Tulipeae

The members have rootstock in the form of a bulb. The stem bears one or more leaves. Flowers mostly large, solitary to racemose-subumbellate. Anthers introrse. Three genera have been presently investigated.

Fritillaria L.

The genus comprises 65 species distributed in the North temperate zone (Airy Shaw, 1973). Five species are met in the western Himalayas. Stewart (1972) reported only two from Kashmir.

F. imperialis L.

This species is well represented in Kashmir. It grows wild and has been brought under cultivation for ornamental purposes.

Root-tip mitosis revealed 2n=24 (Fig. 104). Karyotype consists of 2a+2sm+6st+14t chromosomes falling into four size categories A, C, D and E. Some of the pairs appear heteromorphic (Fig. 105). The chromosomes of pairs 8, 12 and possibly 15 (Fig. 105) possess a secondary constriction in their long arm. Total chromatin length is 353.73 μ and TS% is 16.80. Chromosome size ranges from 23.16 to 12.20 μ and S% is 52.69. Detailed karyotypic formula is 2Bm+2Sm+6Ct+4Dt+2St+2Et+6E. t.

F. rovica hook.

It is wide spread in Kashmir hills at an altitude of
2600-3930 m. The bulb of the plant is of medicinal use.

Root-tip cells revealed 2n=24 (Fig. 106). Karyotype consists of 2m+2sm+1st+1nt chromosomes, falling into four size categories C, D, E and F. Pair number 7, 8, 9, 12 and possibly 11 of the karyogram (Fig. 10) are secondarily constricted in their long arm. Total chromatin length is 325 μ and TF% is 16.81. Chromosome size ranges from 19.9-9.5 μ and 5% is 49.24. Detailed karyotypic formula is 2C3+2Sm+4St+4D+6E5t+2E7t+2F7t.

Lilium Linn.

The genus constitutes 80 species which are North temperate in distribution. Six species occur in the Western Himalayas. Only one species has been worked out here.

L. polyphyllum Don.

Meet in the interior ranges of Kashmir hills at an altitude of about 3075 m. Leaves are employed to alleviate pains of wounds and bruises.

Root-tip cells revealed 12 bivalents at M1 (Fig. 108). Number of chiasmata per bivalent was 2.5. Subsequent divisions of meiosis were normal. Fertility was 100%.

Root-tip cells revealed 2n=24 (Fig. 109). Karyotype consists of 2m+2sm+4st+16t chromosomes falling into four size categories B, C, D and E. Chromosome pairs 2, 9 and 12 are secondarily constricted (Fig. 110). Some of the pairs 1, 2, 5 are heteromorphic. Total chromatin length is 340.64 μ and TF% is 16.52. Chromosome size ranges from 27.66 to 9.86 μ and 5% is 47.74. Detailed karyotypic
formula is $2B^m + 2B^t + 2B^s + 3C^t + 2D^t + 3D^t + 6E^t$.

**Tulipa Linn.**

Airy Shaw (1973) estimated 100 species to be comprising the genus, distributed in the temperate Euroasian regions. Hooker (1894) reported 2 species from the western Himalayas. Stewart (1972) mentioned 2 species occurring in Kashmir of which *T. lena* is suspected to be introduced by Moguls. He considered *T. clusiana* as synonymous of *T. stellata*. But *T. stellata* complex has been treated differently by almost every author who has dealt with it. In a single population in Baluchistan, Stewart (1972) found a great variety of colours.

**T. stellata** Hook.

It is well represented in Mankai and Bandipur area.

Root-tip mitosis revealed $2n=48$ (Fig. 111). Karyotype consists of $6Bm+14St+2Bt$ chromosomes which fall into five size categories F, G, H, I and J (Fig. 112). Total chromatin length is 207.11 $\mu$m and TFB is 13.08. Chromosome size ranges from 8.35 to 2.35 $\mu$m and $54$ is 25.32. Detailed karyotypic formula is $2St^t + 4St^s + 2St^m + 8St^j + 41St^m + 101St^l + 121^t + 2St^m + 41^t$.

**T. clusiana** DC.

The species is widespread in Pampore and Shankaracharya and also common in Baramula. It has several varieties. A natural hybrid between *T. clusiana* and *T. stellata* is named as *T. clusiana* var. *stellata*. Karyotypic studies of the two taxa have been carried out separately.
Julipa clusiana var. typica Regel has 2n=46 (Fig. 113).
It is again a tetraploid. Karyotype consists of 4m+4sm+
2St+12t chromosomes falling into four size categories
G, H, I and J (Fig. 114). Total chromatin length is 229.33 µ
and TF is 16.73. Chromosome size ranges from 7.05 to 2.94 µ
and 5% is 41.70%. Detailed karyotypic formula is 10GSt+4Gt+
4St+4nt+4 1sm+14 1St+4 1t+4Jm.

Julipa clusiana var. atellata also shows 2n=46 (Fig. 115).
Karyotype consists of 2m+2sm+28St+16t chromosomes, falling
into four size categories F, G, H and I (Fig. 116). Total
chromatin length is 260.44 µ and TF is 16.33. Chromosome
size ranges from 8.23 to 3.08 µ and 5% is 36.20. Detailed
karyotypic formula is 2GSt+8Gt+12St+12nt+4nt+2 1Sm+2 1St+
6 1t.

Julipa has shorter chromosomes than the rest of the
members of Tulipae worked out at present.

Tribe : Scilleae

Members of this tribe have tunicated bulb. Leaves
are usually few. Inflorescence without a spathalike bract
at the base, usually racemose. Three genera Hyacinthus,
Muscarl and Ornithogalum have been investigated. All the
three have been introduced in the valley.

Hyacinthus —.

This genus comprises 30 species with Mediterranean-
African distribution (Airy Shaw, 1973). It has many
cultivated forms derived from *Hyacinthus orientalis* L. The hyacinth was introduced into Holland from Lebanon or Taurus mountains about the year 1360. It still exists with a uniform character in its native habitat.

*H. orientalis* L.

This common spring garden plant is cultivated in Kashmir and has become completely naturalised and sometimes occurs as an escape.

Root-tip cells revealed 2n=16 (Fig. 117). Karyotype consists of 8M+2a+4sm+2st chromosomes and fall into four size categories A, B, E and C (Fig. 118). Chromosomes of the 2nd pair are secondarily constricted (Fig. 118). Total chromatin length is 248 μ and TFs is 43.57. Chromosome size ranges from 25 to 632 μ and 5k is 25.25. Detailed, karyotypic formula is 2^A + 6^B + 2^E + 2^ST + 2^C + 2^SM.

*Muscaria* Tourn., ex Mill.

This genus comprises 40 species distributed in Mediterranean region, Europe and Asia (Airy Shaw, 1973). One species has been worked out.

*M. Racemosum* Mill.

Root-tip mitosis revealed 2n=36 (Fig. 119) falling into nine groups, each of four chromosomes (Fig. 120). It is a tetraploid. Karyotype consists of 12M+6a+12sm+4st chromosomes, which fall into three size categories I, J and K. Chromosomes of the group I show heteromorphism in arm ratio and in satellite morphology which is at the end
of short arm. Chromosomes of other groups also show heteromorphocity. Chromosomes of group 3 of karyogram (Fig. 12) are showing satellite at the end of long arm. Total chromatin length is 97.94 µ and TF% is 36.65. Chromosome size ranges from 4.55 to 1.96 µ and S% is 34.72. Detailed karyotypic formula is 4 I°+4 I°+4 I°+4 I°+4 I°+4 I°+4 I°+4 I°.

**Ornithogalum (Tourn.)**

The genus comprises 150 species, distributed in temperate areas of the Old World (Airy Shaw, 1973). Only one species has been studied.

**G. umbellatum**

Root-tip mitosis revealed it to be a triploid with 2n=27 (Fig. 12). The chromosomes fall into nine groups of three each (Fig. 12). Karyotype consists of 3m+9m+12sm+3st chromosomes, falling into five size categories E, F, G, d and i. Chromosomes of the 6th pair (Fig. 12) possess a satellite at the end of their short arm. Total chromatin length is 156.39 µ and TF% is 36.40. Chromosome size ranges from 10.28 to 3.28 µ and S% is 32.63. Detailed karyotypic formula is 3E°+3F°+3G°+3D°+6H°+9 I°.

**DISCUSSION**

*Eremurus*: Present report of n=7, 2n=14 for *Eremurus* himalaicus is in conformity with the reports of previous workers (cf. Table 1). Meiotic observations were interesting
each with a secondary constriction in the long arm besides one pair of median and two pairs of submedian chromosomes in this species. The observations of Mehra and Sachdeva (1976a) are similar to the present. The base number given for the genus is x = 6 (Darlington and Wylie, 1935) and the present taxon is at diploid level. Moffett (1932) reported diploid, tetraploid and octoploid forms in *K. nelsonii*. Webber (1932) studied 7 plants of *K. wyrak* cytologically of which two were found to be chromosomal variants with 2n = 13.

**Hemerocallis**: The present count 2n = 33 for *Hemerocallis fulva* is in agreement with the previous reports (cf., Table I). Plants with 2n = 22 by some workers (cf., Table I) have also been reported. The present taxon being triploid shows irregular meiosis. The karyotype of the present taxon is at variance with that reported by Dark (1932) who stated, the haploid complement to comprise of three pairs of long median/submedian and 2-4 pairs of subterminal chromosomes. Chandler (1946) reported for haploid set 3 median, 3 submedian, 2 subterminal and 3 terminal chromosomes. From India, Vij et al. (1976) found 6 median, 6 submedian, 8 subterminal and 2 nearly terminal chromosomes in the diploid, which is not in agreement with the present observations. It indicates that this vegetatively reproducing species undergoes a dynamic alteration in its karyotype. The base number for the genus is x = 11 (Darlington and Wylie, 1935).
Hosta: both the species of Hosta exhibited 2n=60. This is in conformity with the previous reports (cf. Table I). However, tetraploid with 2n=120 has earlier been reported in H. ventricosa (cf. Table I). Karyologically the two species do not show any marked difference. But meiotically H. ventricosa is medium strong desynaptic while H. plantaginea is weak desynaptic. Chromosomes show great disparity in their size. Whitaker's (1934) classification of the chromosomes in the genus (5 long and 25 short) and that of Sato's (1942) (4 long and 25 short) is not consistent with the present findings, but seems in agreement with the proposed formula of Yasui (1935). A B-chromosome was also observed in H. plantaginea. Both the meiotic and mitotic observations are in support of the 30 as being the base number of the genus. Most of the species are at diploid level having 2n=60, except H. apache, H. ventricosa in which triploids and tetraploids are also known. The two presently worked out species differ only in details of their karyotypic formulae, 5%, 15%. Smaller chromosomes seem to undergo alterations for the speciation in this genus.

Polyborastrum: Five taxa belonging to three species have been worked out. The number 2n=30 for P. seminiflorum as well as its karyotype is in agreement with the findings of Mehr and Sachdeva (1976).

Two cytotypes were found with 2n=22, 2n=28 in P. multiflorum. The size of the chromosomes in the two
A morphological comparison of the presently worked out cytotypes reveals that there is increase in the plant height, length of internodes, leaf and stomatal size in *F. verticillatum* with increase in chromosomal number. But reverse holds good for *F. multiflorum*. The general morphology of the flower remains unaffected.

The genus is reported to have markedly different chromosome numbers which is also supported by the present investigations. The karyotypes too are characterised by marked variation in chromosome size. It, thus, appears that during the evolution of different geographical races, considerable alterations have occurred both in the number and structure of chromosomes. A general tendency of the species is the establishment of the heterokaryotypic states.

*Asparagus*: The present count of 2n=20 for *Asparagus filicinus* confirms the earlier reports (cf. Table I). Exhaustive mitotic studies revealed consistency in its chromosome number except in a population from Hazratbal, Srinagar, in which some cells of roots showed polysomy with 2n=40. Some of the cells also had small B-chromosomes. Bivalent formation was quite regular. Mitotic as well as meiotic studies confirm the base number x=10, for the genus (cf. Darlington and Wylie, 1935). Tetraploids and hexaploids have been reported in other species of the genus by Nagao (1938), Ishii (1935) and Bozzini (1939).
Fritillaria: The two species Fritillaria imperialis and F. roylei, while possessing the same chromosome number \(2n=24\) vary in the details of their karyotypes. The karyotype of F. roylei differs from that reported by Sharma and Sharma (1961b) with 16 median/submedian and 8 subterminal chromosomes but is in agreement with the findings of Chatterjee (1971), Mehra and Sachdeva (1976a).

Darlington (1938) has studied many diploid and triploid species of Fritillaria. The general morphology of karyotype of the presently worked out taxe resembles that of F. askabadensis.

Mehra and Kachroo (1951) described karyotype of F. chirnose with \(2n=24\) as consisting of 2 pairs of submedian and 18 pairs of subterminal chromosomes which is almost similar to present findings. This indicates cryptic structural changes and gene mutations must have played a dominant role in speciation of this genus.

Lilium: The present count of \(n=12, 2n=24\) for Lilium polyphyllum confirms the earlier report for the species (cf. Table 1). Stewart (1947) made a comprehensive study of the karyotypes of 48 species and varieties of this genus. He found some species possessed three different karyotypes. The number, and position of secondary constriction was also found to be variable. B-chromosomes were observed in a number of species. There is report of some aneuploids too (Stewart, 1943, 1947). Polyploidy is rather rare in the
genus. Triploids with \( 2n=36 \) have been reported by Sen (1976) for \( L. japonicum \) and \( L. tigrinum \). Mehra and Kachroo (1951), and Sen (1976) have arrived at the conclusion that structural changes in chromosomes have played a dominant role in speciation in this genus.

**Tulips:** Both the species, *Tulipa stellata* and *T. clusiana*, are tetraploids with \( 2n=48 \). The present counts confirm the reports of some workers but is also at variance with others (cf. Table I). There is some taxonomic confusion between the two species. Stewart (1972) placed *T. clusiana* as synonym of *T. stellata*. Differences in leaf morphology and texture, and flower colour do not support this contention. The two differ in details of their karyotypes as well. A hybrid, *T. clusiana* var. *stellata*, has the same chromosome number. All the three taxa possess mostly st and t chromosomes but there is a general variation in the chromosome size. The complexity of *T. stellata* seems to be due to some flexibility in the morphological characters. Gene mutations with minor structural changes seem to have led to speciation in the genus. Like some members of Alliaceae, the tulips in general are characterised by gross similar pattern of chromosome morphology. Continuous clonal propagation has helped in maintaining the minor structural alterations in chromosomes.

**Hyacinthus:** The present count of \( 2n=16 \) for *Hyacinthus orientalis* is in agreement with the previous reports.
Muscari: The present count of \(2n=36\) for *Muscari racemosum* confirms the findings of some of the previous workers (cf. Table I). The present taxon is tetraploid. Some different numbers in the species with \(2n=44, 45, 56\) have also been reported earlier (cf. Table I). Asymmetry in the chromosomes in the most of the groups of karyogram suggests mixing of different genomes. The base number for the genus is \(x=9\).

*Ornithogalum*: Present count of \(2n=27\) for *Ornithogalum umbellatum* confirms some of the earlier reports (cf. Table I). However, various other numbers \(2n=18\) to \(2n=90\) have also been reported (cf. Table I). Polyploid series with \(2n=18, 27, 36, 43, 45, 52, 54, 72\) were found by Neves (1952). \(B\)-chromosomes in a diploid taxon, \(2n=18\), have been reported by Rejon (1976). The presently investigated taxon is triploid.

Cytologically the species is very plastic since, besides polyploid numbers, aneuploid numbers are also reported (cf. Table I). Different base numbers for the genus *Ornithogalum* have been suggested (cf. Darlington and Hylle, 1953).

FAMILY: THILOJACEAE Lindl.

Hutchinson (1934) segregated most of the woody nonxerophytic members from the family Liliaceae and placed
them into several distinct families like Smilacaceae, Muscaceae and Philesiaceae. He also raised the tribe Parideae of Krause (1930) to the family level designated as Trilliaceae, comprising 4 genera and 53 species on the plea that they differ from Liliaceae in having terminal whorled leaves, 4-12 stamens and 3-10 carpels as also opined by Ecker (1976). Only one genus has been worked out at present.

**Trillium L.**

The genus consists of 30 species (Alry Shaw, 1973). A few of them are Himalayan, Chinese, Japanese, but most are North American. Only two species are reported from India of which one is found in Kashmir.

**T. govanianum L.**

A fairly common plant in the hills during spring and summer months, distributed at 2700-3000 m in Kashmir.

Shoot tip mitosis revealed 2n=20 (Figs. 123, 125) and 2n=20+20's (Fig. 127). Karyotypes of various populations showed slight variations.

Culmarg population possesses 4A+4m+2a+6s+4t chromosomes falling into four size categories C, D, E and F (Figs. 123, 124). Chromosomes of 4th pair of karyogram (Fig. 124) bear interstitial satellite near the centromeres. Total chromatin length is 330.47 µ and TF is 39. Chromosome size ranges from 27.96 to 11.29 µ and 5% is 33.86. Detailed
Karyotypic formula is $4D^4 + 2C^1 + 4D^m + 4D^s + 4D^t + 28^m$.

Karyotype of Baltal population (Figs. 123, 125) consists of $24 + 4m + 6s + 4t + 4t$ chromosomes falling into three size categories C, D, and E. Total chromatin length is 277,97 μ and TP% is 31.20. Chromosome size ranges from 18.54 to 9.27 μ and 5% is 9. Detailed karyotypic formula is $2C^4 + 2C^m + 2D^s + 4D^t + 2E^m + 4E^s + 4E^t$. In addition some of the cells showed 2 B chromosomes (Fig. 127).

DISCUSSION

The present count of 2n=20 for *Isollium covenianum* confirms the findings of Mehta (1966) in Eastern Himalayas, and Mehra and Saanева (1976a, 1977) in Western Himalayas and others (cf. Table I). The karyotypes of different populations, however, showed some difference in the size of chromosomes as well as in the position of centromeres. The range of chromosome size in different populations was from 20.96 to 9.27 μ and revealed consistency in having a single pair of secondarily constricted chromosomes. Mehra and Saanева (1976a, 1977) on the other hand reported chromosome size range from 27 to 12 μ and also observed variation in the number of secondary constrictions in the chromosomes constituting one median, one submedian and two subterminal pairs. Present investigations agree to a certain extent with the figure of Mehta (1966) depicting two pairs of median, four pairs of submedian and
four pairs of subterminal chromosomes with a secondary constriction in two subterminal pairs only. The present variation of chromosome size found among the different populations may be due to variation in condensation or non-spreading of chromosomes. Mehra and Saondeva (1977) have reported karyotypic polymorphism in this species.

**FAMILY : PLANTAGINACEAE Kunth**

A family of 6 genera and 30 species mostly tropical in distribution, especially in tropical Africa and America (Airy Shaw, 1973). It includes marsh and fresh water herbs with erect or floating leaves. Only one genus is found in Kashmir.

**Monochoria Presl.**

The genus embraces 3 species which are well represented in the tropics of the Old World (Airy Shaw, 1973). Two species occur in the western Himalayas and only one in Kashmir.

**M. vaginata Presl.**

The species is a weed in paddy fields. The root of the plant is chewed for toothache and the bark eaten with sugar for asthma.

Root-tip mitosis revealed 2n=32 (Fig. 12b). Chromosomes are small in size. The present count of 2n=32 is in conformity with the findings of Krishnappa (1971), but not with that of Hsu (1967) who reported 2n=28. Sharma and
Sarkar (1967-68) reported 2n=40, 52, 80 for this species. The presently worked out taxon is at diploid level with base number x=26 (Darlington and Wylie, 1935). The other base number suggested for the genus is x=14.

FAMILY: ALLIACEAE Agardh

Systematic position of the genus *Allium* has been much debated. Hooker (1894), Krause (1930), placed *Alliums* in the family Liliaceae because of superior ovary. Hutchinson (1939, 1972) included the genus in Amaryllidaceae because of umbellate inflorescence subtended by an involucre of one or more bracts which he considered to be a character of the family. Traub (1968) assigned it a subfamily rank under Amaryllidaceae. Nasir (1973), while describing the Alliums of Pakistan, placed the genus in a separate family Alliaceae which includes 30 genera and 700 species.

Steam (1946) recognized 14 sections in the genus *Allium* from the old world, namely Melanocormum, Moly, Briseis, Microspermum, Chamaeprason, Xanthoprasum, Ophiocormodon, Cepa, Phyllocladon, Haemoprasum, Codonoprasum, Rhiziridium, Anguinum and Alliotypus. Hooker (1894) grouped Indian wild Alliums into 3 sections: Schoenoprasum, Rhiziridium and Melium. The status of sections was based on rootstock, the leaf type and the nature of membranes enclosing the bulbs.

Airy Shaw (1973) reported 450 species belonging to the genus *Allium* distributed mainly in the North temperate
regions. Kazakova (1973) mentioned 600 species in the
genus. From Kashmir Stewart (1972) reported 29 species
belonging to this genus. Most of the species have a
distinct smell of garlic and onion. Some of them are
used as vegetables, condiments and for decorations. A
few have medicinal importance.

A study of the literature reveals that the genus
has been fairly investigated since Nemes (1898a) and
Schaffner (1898) worked out the cytology of *Allium cepa.*
Since then a number of cytologists have worked on this
genus (cf. Table 1) since it yields ideal material for
cytological studies. So far about 380 species have been
cytologically examined (cf. Darlington and Wylie, 1935;
Fedorov, 1969; Moore, 1973; IUP3 chromosome numbers in
Taxon upto 1976).

Presently 19 taxa belonging to 18 species of *Allium*
met in Kashmir have been cytologically examined.

Section: Schoenoprasum

Bulbs free or clustered, not seated on a rootstock.
Leaves of two types, fistular or filiform. Those with
fistular leaves are *Allium fedtschenkoanum* and *A.* schoenoprasum,
and the ones with filiform leaves are *A. jacquemontii,*
*A. kachoeri* and *A. griffithianum.*

*Allium fedtschenkoanum* Regel

The species occurs in Baltal, Amarnath, Panchtarni
and Meenamarg areas of Kashmir hills at an altitude of
3000 to 4100 m.

Chromosome number was determined both from PMC's and root-tip mitosis. PMC's revealed n=8 (Figs.129-131). At diakinesis the chiasmata were both interstitial as well as distal (Fig.129). In some cells chiasmata were in the centre of a bivalent (Fig.131), while in others they were mostly of D-type, or a few of B-type as well (Fig.130). The average number of chiasmata per bivalent was 1.3. The chromosome distribution at A1 is normal (Fig.132), followed by normal meiotic course. Pollen fertility was 92%.

Root-tip cells showed 16 chromosomes (Fig.133) which could be arranged into 8 pairs (Fig.134). Karyotype consists of 6M+8m+2t chromosomes, which fall into two size categories M and m. Total chromatin length is 81.76 u and IF is 40.73. Chromosome size ranges from 6.16 to 4.25 u and 5% is 63.85. Detailed karyotypic formula is 4M+6m+2t+2 1M+2 1m.

A. schoenoprasum Linn.

The species grows abundantly at Kotha near Sheeshaag, Amarnath, and Meenamarg at an altitude of 3600 m. The plants of the two different localities showed morphological differences. Those of Kotha were gigantic as compared to the other.

Chromosome studies were made of both the populations from PMC's as well as root-tip cells. PMC's revealed 8 bivalents in both cases at diakinesis (Fig.135). Chiasmata
were interstitial at diakinesis but at M₁ some of them were D-type (Fig. 136). The average number of chiasmata per bivalent was 2. In most of the cells a pair of bivalents showed close association looking like quadrivalent (Fig. 136). Chromosome distribution at A₁ was normal (Fig. 137). In some cells a laggard (Fig. 136) or a bridge (Fig. 140) could be seen at A₁. Some of these laggards showed early separation of chromatids (Fig. 139). Stickiness was noticed at M₁I (Fig. 141). At A₁II bridges (Fig. 142) and at I₁II extrusion of chromatin bodies resulted in unequal distribution of chromatic material (Fig. 143).

Root-tip mitosis revealed 2n=16 in both the populations (Figs. 144, 146). Karyotype of Ketha population consists of 2M+12m+2T chromosomes, falling into three size categories E, G and I (Figs. 144, 145). Total chromatin length is 101.1 μ and TF% is 41.34. Chromosome size ranges from 8.29 to 4.73 μ and S% is 57.29. Detailed karyotypic formula is 2E⁶+4G⁶+2m⁶+6m²+2T. Karyotype of Meenamang population consists of 2M+12m+2T chromosomes, falling into three size categories E, F and G (Figs. 145, 147). Total chromatin length is 137.36 μ and TF% is 41.63. Chromosome size ranges from 11.46 to 7.06 μ and S% is 60.72. Detailed karyotypic formula is 2E⁶+2F⁶+2m⁶+6m²+2T. The two populations thus also differ in their karyotypes.
A. jacquemontii Kunth

The plant material was collected from Dras, POCO's revealed n=8 (Fig.148). The chiasmata were of F-, M- and D-type, but not localised. Chiasmata number on the average per bivalent was 1.2. Pollen fertility was 92%.

Root-tip cells showed 2n=16 (Fig.149), arranged into eight pairs (Fig.150). Karyotype consists of 6M+8m+2st chromosomes falling into two size categories H and I. Total chromatin length is 73.30 μ and TF% is 44.33. Chromosome size ranges from 3.35 to 4.03 μ and 5% is 76.37. Detailed karyotypic formula is 2H⁴+4H²+4 I⁴+4 I² 2 Ist.

A. kacchaperi Singh

This is a new taxon described by Singh (1977). It occurs abundantly on hill-side around Mansbal lake at an altitude of 1750 m. The species is close to A. jacquemontii.

Chromosomes were counted both from POCO's and root-tip cells. POCO's revealed n=6 at α₁ (Fig.151) and 2n=16 at α₁ (Fig.152). Chiasmata were almost localised and most of them of D-type. They numbered on the average 1.8 per bivalent. Chromosome distribution at α₁ as well as at subsequent stages of meiosis was normal. Pollen fertility was 94%.

Root-tip cells showed 2n=16 (Fig.153), arranged in 8 pairs (Fig.154). Karyotype consists of 2H₄+12m+2st chromosomes, falling into two size categories G and H. Total chromatin length is 86.69 μ and TF% is 44.36. Chromosome
The size ranges from 6.39 to 4.77 μ and S% is 74.64. Detailed karyotypic formula is 26^a+24^b+10^c+24^d.

*A. griffithianum* Boiss

It grows as a weed in saffron (*Crocus sativus*) fields in Balhama, Pampore, Lathpora area.

Meiosis was characterised by multivalent formation. Chromosomes showed general stickiness (Fig. 155). Six quadrivalents and one octavalent were seen at diplotene stage (Fig. 155) in 8% of cells. Other cells showed variable number of bivalents and multivalents. Univalents were also seen in some cells. Some quadrivalents formed rings at M1 (Fig. 156). The early movement of chromosomes at M1 towards poles was also observed (Fig. 157). In majority of the cells there was equal distribution of chromosomes at A1 (Fig. 158). In some cells chromatids of a chromosome showed early separation at A1 (Fig. 159). Their fate at AII could be erratic. Laggards, bridges and unequal chromosome distribution were seen at T1 (Fig. 160). Pollen fertility was 70%.

Root-tip cells revealed 32 chromosomes (Fig. 161), arranged into eight groups, each of four similar chromosomes (Fig. 162). The species appears to be an auto-tetraploid. Karyotype consists of 8M+24n chromosomes falling into two size categories F and G. Four chromosomes of group 3 (Fig. 162) probably possess secondary constriction near the centromere. Total chromatin length is 234.98 μ and TF% is 45.34. Chromosome size ranges from 9.83 to 7.26 μ and S%
is 56.4%. Detailed karyotypic formula is $4F^M + 8F^m + 4G^M + 16G^m$.

Section: Anisiridium

Bulbs in this section are solitary or clustered on an erect or creeping rootstock. Leaves flat. The species in which bulb scales are membranous and stamens longer than the perianth, are *A. consanguineum*, *A. stragheyi*, *A. blendus* and *A. thomsoni*. Others in which the bulb scales are of reticulated fibres are *A. victorialis*, *A. humile* and *A. tuberosum*. The former has stamens longer than the perianth but the position is reverse in the latter two species.

*A. consanguineum* Kunth

Widely distributed in the Kashmir hills.

PMC's revealed 8 bivalents at $M_1$ (Fig. 163). Chiasma number per bivalent varied among different populations but the average was 2. Chromosome disjunction was normal at $A_1$ (Fig. 164). Subsequent divisions too were normal. Pollen fertility was 100%.

Root-tip cells revealed 16 chromosomes (Fig. 163) which could be arranged into 8 pairs (Fig. 166). Karyotype consists of $4F + 10F + 2G$ chromosomes, falling into three size categories $F$, $E$ and $G$. Seventh pair is heteromorphic (Fig. 166). The 8th pair possesses an interstitial satellite adjacent to the centromere on the long arm (Fig. 166). Total chromatin length is 15.02 $\mu$ and TFS is 44.72. Chromosome size ranges from 11.61 to 7.62 $\mu$ and 6% is 60. Detailed karyotypic formula is $2E^M + 6E^m + 2F^M + 2F^m + 2F^t + 2G^m$. 
A. stracheyi Baker

The material was collected from Neelpanch, Harwan and Simpohon pass. The plants do not grow abundantly. However, those from two different areas did not show any substantial morphological variation.

FMC's revealed 8 bivalents at M₁ (Fig. 167) with mostly D-type chiasmata. Occasionally a bivalent exhibited F-type chiasma. In some cells early disjunction of bivalents was noticed (Fig. 168) revealing a weak desynaptic tendency. Average number of chiasmata per bivalent was 2. Segregation of chromosomes was normal at A₁ (Fig. 169). Pollen fertility was 100%.

Root-tip mitosis revealed 2n=16+18 (Fig. 170). Karyotype consists of 10m+4sm+2st chromosomes falling into two size categories F and G (Fig. 171). Chromosomes of 7th pair possess an interstitial satellite adjacent to the centromere on the long arm. One B-chromosome looking like a fragment was also noticed. Total chromatid length is 127, 20 µ and TFM is 41.09. Chromosome size ranges from 9.33 to 6.76 µ and 5% is 72.80. Detailed karyotypic formula is 6F²+2Fₘ⁴Gₘ⁴+2Gₘ+2Gₘ+2Gₘ+2st.

A. blandum Wall.

The plants in the valley are confined to an altitude of 2800 to 3500 m.

Root-tip mitosis revealed 32 chromosomes (Fig. 172) which could be arranged into 16 pairs (Fig. 173). The species is an allo-tetraploid. Karyotype consists of 26m+2sm+2st
chromosomes, falling into 4 size categories E, F, G and H. Chromosomes of individual pair show symmetry from length and arm-ratio point of view. The chromosomes of 16th pair (Fig. 173) have a satellite at the end of short arm. Total chromatin length is 256.34 μ and TFR is 43.96. Chromosome size ranges from 19.72 to 5.28 μ and 5% is 46.35. Detailed karyotypic formula is 2E+m+2E+6E+m+12E+m+2F+m.

A. thomsonii Baker

The species grows abundantly in Zoila, Baltal, Amarnath cave area above 2775 m. Root-tip mitosis showed 32 chromosomes (Fig. 174) arranged into 16 pairs (Fig. 175). The species is allo-tetraploid. Karyotype consists of 30+24m+3m+2st chromosomes, falling into four size categories D, E, F and G. Chromosomes of the 1st pair (Fig. 175) are heteromorphic with respect to arm ratio and length. Chromosomes of the 16th pair possesses a satellite the end of short arm. Total chromatin length is 302.72 μ and TFR is 42.32. Chromosome size ranges from 14.33 to 6.87 μ and 5% is 43.35. Detailed karyotypic formula is 1D+m+1E+m+1E+m+2m+2F+m+12F+m+2E+m+2F+m+2F+m.

A. victoriae L.

It grows commonly in the Kashmir hills at an altitude of 2700 to 3000 m. Ledwes, Neelpanch, Harwan populations vary in size from those at Gulmarg, Sonamarg and Baltal. Plants from Neelpanch were gigantic, almost double the size of plants collected from Gulmarg and Sonamarg. Plants of
Baltai area were of intermediate size.

MIC’s in all populations revealed n=6 (Figs. 176, 177). The number of chiasmata per bivalent varied slightly in the geographically isolated populations. It ranged from 2 to 2.6 per bivalent. All the three P-, M-, and D-types of chiasmata were seen (Figs. 176, 177). Homologous chromosomes of bivalent formed loops at diakinesis and a number of small dot like nucleoli were seen at this stage (Fig. 176). M1 was perfect (Fig. 177) and 6 chromosomes moved to each pole at A1 (Fig. 178). Occasionally a fragment was noticed (Fig. 179). Tetrad formation was normal and pollen fertility 100%.

Root-tip mitosis revealed 2n=16 (Figs. 180, 182).

Karyotypes of Bonampak, Baltai and Gulmarq populations were similar. A typical karyotype consists of 11m+3sm+2st chromosomes falling into 2 size categories D and E (Figs. 180, 181). Chromosomes of the 1st pair are secondarily constricted in their long arm (Fig. 181). Chromosomes of the 1st and 7th pairs (Fig. 181) are heteromorphic. Total chromosome length is 193.80 µ and TF% is 44.55. Chromosome size ranges from 13.00 to 17.10 µ and S% is 62.73. Detailed karyotypic formula is 6Dm+1Dsm+3Em+2Esm+2Est.

Karyotype of Ledwas, Neelpanch populations consists of 9m+9sm+2st chromosomes falling into 2 size categories D and E (Figs. 182, 183). Chromosomes of the 1st pair of karyogram (Fig. 183) are secondarily constricted in long arm. Chromosomes of pairs 1 and 4 are heteromorphic (Fig. 183). Total chromatin length is 212.14 µ and TF% is
36.33. Chromosomes size ranges from 16.00 to 11.03 µ and S% is 71.12. Detailed karyotypic formula is 6Dm+3Dsm+2DSt+3E. Karyotypes in both the morphotypes are asymmetrical, with respect to arm-ratio and length basis.

*A. humile* Kunth

Plants were collected from several localities mentioned in Table I. They grow abundantly in Kashmir at an altitude of 3000 to 4000 m. Practically no morphological variations were noticed among the various clones of a population, but the populations from different localities were found to vary in quantitative characters. Plants from Sonamarg, Baltal, Amarnath region are long with greater length and breadth of leaf, higher number of flowers per inflorescence and longer stalks, as compared to the plants of Burgha population.

The chromosome number was determined both from RAM's, and root-tip cells. RAM's revealed n=8 (Fig.184). Chiasmata number per bivalent was 2.3 on an average and they were of D- or M-type. Pollen fertility was 95%.

Root-tip cells showed 2n=16 in all the populations (Figs.185,187). Karyotype of Burgha population (Fig.185) consists of 8m+6sm+2st falling into three size categories D, E and F and could be arranged into eight pairs (Fig.186). Chromosomes of 8th pair showed a satellite at the end of the short arm (Fig.186). Total chromatin length is 174.63 µ and TPD is 38.24. Chromosome size ranges from 13.21 to
8.57 μ and 83 is 64.87. Detailed karyotypic formula is
20E^m +6E^m +4E^m +2E^m +2F^m +2F^m.

Karyotype of Baltai populations consists of 10m+4sm+
2st chromosomes, falling into three size categories D, E
and F and could be arranged into 8 pairs (Figs. 187, 188).
Chromosomes of the 8th pair showed a satellite at the
end of short arm (Fig. 188). Total chromatin length is
159.92 μ and TFS is 39.17. Chromosome size ranges from
13.67 to 8.36 μ and 83 is 61.62. Detailed karyotypic
formula is 20E^m +6E^m +4E^m +2E^m +2F^m +2F^m.

The karyotypes of the two localities do resemble
much with each other.

*A. tuberosum* Roth. ex Spreng.

The species is quite rare in Kashmir.

Meiosis was erratic. At early diplotene stage six
patches of chromatin networks were observed in most of
the cells (Fig. 189). A Rener-type-like structure of
condensed chromosomes was seen at diakinesis (Fig. 190).
Since this complex failed to orient itself on a normal
metaphase plate, the chain opened up, undergoing desynapsis.
Such cells were common (Fig. 191). The plant belongs to
the category of medium weak desynaptic type. At M1 were
seen univalents, bivalents and multivalents (Figs. 192, 193).
In some MMC's, 1 hexavalent, 4 quadrivalents, 1 trivalent,
1 bivalent and 5 univalents were seen (Fig. 192). In others
6 quadrivalents, 2 trivalents and 1 bivalent, or
7 quadrivalents, 1 trivalent and 1 univalent were seen (Fig. 193). About 1,5% cells showed 8 quadrivalents per cell, 8% showed 7 quadrivalents per cell, 25% showed 6 quadrivalents per cell, 30, 5% showed 2-5 quadrivalents per cell, 1% showed 16 bivalents per cell, and 15% cells were completely desynaptic. Reticulate connections at early A1 (Fig. 194) and bridges with laggards and fragments were frequent at late A1 (Fig. 193). A lagging chromatid is seen at I1 (Fig. 196). Unequal nuclei due to abnormal chromosome distribution were noticed at this stage (Fig. 197). Some M1's with quite high chromosome numbers were seen at M1 (Fig. 198). Chromatin droplets were extruded at I11 (Fig. 199). Triad formation was common (Fig. 200). Pollen fertility was only 50%.

Root-tip cells showed 2n=32 (Fig. 201), which could be classified into 8 groups of four each (Fig. 202). Karyotype consists of 4E+22M+2m+4st chromosomes, falling into three size categories E, F and G. Chromosomes of the Gth group possess a satellite each at the end of short arm. Total chromatin length is 312.5 μ and TF% is 41.61. Chromosome size ranges from 13 to 6.39 μ and S% is 45.59. Detailed karyotypic formula is 4E+12E+2E+2m+10F+4St. The species seems to be auto-tetraploid with abnormal genetic behavior.

Section: Melium

Members of this section possess bulbs not seated on a rootstock. Leaves flat or keeled. Spathes are shorter.
than the head.

*A. cepa* L. (Fig. 203). The average number of chiasmata was 2.9 per bivalent.

Somatic count from root-tip cells showed 16 chromosomes (Fig. 204) arranged in 8 pairs (Fig. 205). Karyotype consists of 10m+6sm chromosomes, falling into three size categories C, D and E. Chromosomes of 8th pair possess a satellite at the end of short arm. Total chromatin length is 222.83 μ and TF% is 41.23. Chromosome size ranges from 29.37 to 9.18 μ and 5% is 44.62. Detailed karyotypic formula is $2C^{a}+6D^{a}+2E^{a}+6E^{m}$.

Cultivated Alliums

*A. cepa* Linn.

Various populations studied (cf. Table I) revealed 2n=16 in the root-tip cells (Fig. 206). These could be arranged into 8 pairs (Fig. 207), consisting of 2m+10m+2sm+2st chromosomes falling into three size categories E, F and U. Sixth pair (Fig. 207), possesses a satellite on the short arm of the chromosomes. Eighth pair is slightly heteromorphic. Total chromatin length is 138.98 μ and TF% is 41.49. Chromosome size ranges from 11.91 to 7.35 μ.
and 5% is 61.73. Detailed karyotypic formula is $6^M + 2E^M + 2F^M + 2F^S + 2G^M$.

*A cespia var. cespia Linn.*

Several populations from different areas as mentioned in Table I revealed $2n=16$ (Fig. 208) from root-tips. They could be arranged in 8 pairs with a high concordance in their karyotype. The latter consists of $12m+2am+2at$ chromosomes, falling into three size categories E, F and G. Chromosomes of the 7th pair (Fig. 209), possess a satellite at the end of the short arm. Total chromatin length is 163.47 $\mu$ and TF% is 42.98. Chromosome size ranges from 11.61 to 7.62 $\mu$ and 5% is 65.64. Detailed karyotypic formula is $10^M + 2F^M + 2F^S + 2G^M$.

*A sativum Linn.*

All the clones of this species have the karyotype of $2m+8m+4am+2at$ chromosomes (Figs. 210, 211) or $2m+10m+2am+2at$ chromosomes (Fig. 212) falling into four size categories E, F, G and H. The three shortest pairs, 6, 7 and 8 (Fig. 211), are recognizable individually. Chromosomes of 6th and 7th pairs (Fig. 211) both have interstitial satellites next to the centromere. Chromosomes of 7th pair are asymmetric on the basis of arm ratio and length. The two satellited pairs have essentially the same gross organisation, their short arms being divided into a small proximal segment and a satellite. Total chromatin length is 174.26 $\mu$ and TF% is 42.47. Chromosome size
ranges from 14.11 to 8.38 u and S is 57.89. Detailed karyotypic formula is 20^A+4B^m+6E^m+4F^m+2P^6t+2C^m.

A. macleanii Baker

It grows in graveyards at Mahagam at an altitude of 1700 m and seems to be introduced.

Chromosome number was determined from PMC's which revealed 8 bivalents at $M_1$ (Fig. 213). The average number of chiasmata per bivalent was 2.4. They are of D-, M- and P-types.

A. porrum L.

It grows wild in Kashmir and is also cultivated. It exists in three forms (i) Leek (ii) Great headed garlic (iii) Peer. The last one is wild and grows in the kerawas of Lathipora, Pampore.

A. porrum L. (Peer)

Chromosome studies were made both from the PMC's and root-tip cells. Meiosis in PMC's is aberrant. The plants are strongly desynaptic. Renner-complex-like structures were seen at dikineses (Fig. 214). Primary associations into quadrivalents and their desynaptic trends were seen at diplotene (Fig. 215). Normal condensation of desynaptic chromosomes is observed at $M_1$ (Fig. 216). Distribution of condensed chromosomes is occasionally normal but of uncondensed ones in general is abnormal (Fig. 217) which results in laggards and fragments. Upto
5 chromatin droplets formed by laggards and fragments were observed in some cells at T₁ (Fig. 215). Subsequent stages were also irregular (Fig. 219). Pollen fertility was only 9%.

Root-tip cells showed 32 chromosomes (Fig. 221) which could be arranged in 8 groups of four each (Fig. 222). Karyotype consists of 24m+8sm chromosomes, falling into three size categories D, E and F. Chromosomes of 4th and 7th groups are secondarily constricted (Fig. 222). In 7th group secondary constriction is very near the centromere, thus giving appearance of a small interstitial satellite. Total chromatin length is 374.70 μ and TF% is 42.55.

Chromosome size ranges from 13.65 to 17.07 μ and 5% is 64.34. Detailed karyotypic formula is 12E₄+8E₃m+6E₂m+4F₄m. The taxon seems to be an auto-tetraploid.

**Allium porrum** L. (great headed garlic)

Plant material was collected from Srinagar.

Root-tip cells showed 2n=48 (Fig. 223). These chromosomes could be arranged in 16 groups of three each. Karyotype consists of 9M+27m+6sm+3st+3t chromosomes, falling into four size categories E, F, G and H. Chromosomes of groups 3, 11 and 14 (Fig. 224) are secondarily constricted. Total chromatin length is 382.32 μ and TF% is 46.47.

Chromosome size ranges from 11.20 to 3.43 μ and 5% is 48.42. Detailed karyotypic formula is 3E₂m+3F₃m+3F₂m+9G₁m+3G₁st+12E₄m+6E₃m+3E₂m+3F₁m+3F₁st. The taxon is hexaploid.
DISCUSSION

Of the 19 taxa belonging to 16 species of *Allium* investigated n=6, 2n=16 for *A. sedetschenkoanum*, n=6, 2n=16 for *A. humile*, n=6, 2n=16 for *A. jacquemontii* and n=8, 2n=16 for *A. kacheori* furnish the first cytological reports for the species. The present count of 2n=16 for *A. schoenoprasum* confirms the previous reports (cf. Table I). Levan (1936a), however, observed three cytological races with 2n=16, 24, 32. The present count of 2n=32 for *A. griffithianum* is in conformity with the findings of Koul and Kohli (1971) but is not in agreement with the findings of Vakhtina (1969) who reported 2n=16. The count of n=6, 2n=16 for *A. consanguineum* confirms the reports of Mehra and Sachdeva (1976b) who observed 2n=16, and Kohli and Koul (1976) who observed n=6. The present report of 2n=16+1B for *A. stacechi* also confirms the findings of Mehra and Sachdeva (1976b) for the A-chromosomes, but this number is at variance with the findings of Sharma and Aiyangar (1961) who observed 2n=14+2 A 10B, 26, and Shopova (1966) who reported 2n=14+2 A 10B. The count of 2n=32 for *A. blandum* confirms the findings of Koul and Kohli (1973), and Mehra and Sachdeva (1976b). The count of 2n=32 for *A. thomsonii* too confirms the earlier reports (cf. Table I). Present count of 2n=16 for *A. victorialis* is in conformity with the findings of some previous workers (cf. Table I), but differs from others who observed 2n=32, 2n=36 (cf. Table I). Present
count of 2n=32 for A. tuberosum agrees with the findings of some previous workers, and the same holds good for A. stenopetalum and A. aegalonicum with 2n=16 and for A. macleanii with n=6 (cf. Table I). The present count of A. cepa var. cepa with 2n=16 is also in agreement with the earlier reports, but D'Amato (1948) found a tetraploid with 2n=32. The diploid number 2n=16 for A. sativum is the same as reported earlier. The findings of 2n=32 for A. porrum confirms the findings of some previous workers (cf. Table I), and the count of 2n=48 for A. porrum (great headed garlic) confirms some of the earlier reports for the species although Kollman (1970) observed other cytotypes too with 2n=16, 24, 32, 40, 46 and Botmer (1970) 2n=32, 40, 46.

The genus Allium has three basic chromosome numbers i.e. 7, 8 and 9. The Old world species of section Codonoprasum comprising mainly European and west Asiatic bulbous species and the species of A. porrum section of Mediterranean region possess all the three basic numbers. In the section Codonoprasum most of the taxa have basic number 8, except a few like A. fuscum with x=7 and A. pseudoflavenum with x=9. In the new world, except for a few like A. schoenoprasum, A. tricoccum with x=6, all the North American species constituting a large group of closely linked species have the basic chromosome number x=7.

Chromosome number in all the 19 taxa worked out presently are based on x=6. A perusal of the literature
reveals that *A. neapolitanum* (Khoshoo and Sharma, 1939a) and *A. stracheyi* (Sharma and Aiyanger, 1961) are the only exceptions which have \( x = 7 \). Thus the species with \( x = 8 \) dominate the area. This is independent of the morphological characters like rhizomatous or bulbous underground parts, which represent an adaptation to environments with a marked climatic variation in North-west area of India.

Polyplody: Among the members of the genus *Allium* so far investigated, 32\( ^{a} \) are polyploids (cf. Fedorov, 1969; Moore, 1973; ICRB chromosome number reports in *Taxon* upto 1978). Of the 19 taxa of *Allium* presently studied, 13 are diploids, 5 tetraploids and only one hexaploid, which works to 31.57% polyploidy. *Allium griffithi* (2\( n = 32 \)), *A. porrum* (Peer) (2\( n = 32 \)) and *A. tuberosum* (2\( n = 32 \)) are auto-tetraploids, while *A. blandum* (2\( n = 32 \)) and *A. thomsonii* (2\( n = 32 \)) are allo-tetraploids. *Allium porrum* (great headed garlic) (2\( n = 48 \)) is also an allo-hexaploid.

Detailed karyotypic analysis on 18 taxa reveals that their chromosomes fall between C to I size categories and each species has 2 to 4 size grades. All the types i.e. \( \vec{m}_n \), m\( ^{-} \), \( \vec{m}_m \), et\( ^{-} \), t\( ^{-} \), and I- chromosomes are present in the genus.

Heteromorphism: Distinct heteromorphism among some bivalents is observed in *Allium victorialis*, *A. thomsonii* and to a lesser extent in *A. senecocarpum*, *A. griffithii*, *A. consanguineum*, *A. humile*, *A. tuberosum*, *A. atropurpureum*. 
The heteromorphocity in the karyograms in the above mentioned taxa may be either dynamic structural chromosomal alterations due to deletion, duplication, inversion and translocation, or due to hybrid origin of the plant.

Satellite Ann and Secondary Constrictions: This is the most common feature found in most of the species of the genus Allium. Satellites of interstitial type are observed in A. griffithianum, A. consanguineum, A. stacechevi, A. sativum and tandem satellites are found in A. blandum, A. thomsonii, A. humile, A. tuberosum, A. stropypurreum, A. asclepioides, and A. sess. Secondary constrictions are found in A. victorialis and A. porrum. Among diploids mostly only a single pair of chromosomes is having a secondary constriction and/or satellite, except A. sativum which has two pairs of chromosomes with interstitial satellites.

Meiotic features: Meiosis has been studied in 12 taxa. Diploids form normal bivalents. Multivalents were seen in A. tuberosum, A. griffithianum and A. porrum (2n=32) (all auto-tetraploids). Chiasma frequency has been examined in most of the diploids. It has been found that the percentage of chiasmata per bivalent decreases with the decrease in chromosome size. It is low in A. fedtschenkoanum and quite high in A. victorialis, A. stropypurreum. The higher number of chiasmata per bivalent may cause sometimes late disjunction or fragmentation as is evident in
A. victorialis - the cause for karyotypic polymorphism in the species. Non-localisation of chiasmata, or centric chiasmata has been found in the members of Schoenoprasum group. Laggards, fragments, micronuclei and bridges were observed in A. schoenoprasum, A. griffithianum, A. tuberosum A. porrum (Peel) during meiosis and only fragments were seen in A. victorialis. Desynapsis was noticed in A. tuberosum, A. stracheyi and A. porrum (2n=32). The last is a strong desynaptic plant. The chromosomes in most of PMC's showed little condensation during the kinetic phase of meiosis. The number of nucleoli is high in desynaptic tetraploid plants. Among diploids A. victorialis has a number of small nucleoli. Pollen fertility is highest in diploids and low in tetraploids and lowest in desynaptic tetraploids.

Section: Schoenoprasum

The presently worked out members of the section Schoenoprasum are characterised by small-sized chromosomes with centromere of M- or M- category, except the two members A. schoenoprasum and A. fedtschenkoanum which have a pair of I- or I- chromosomes as well. Meiotic features in these plants are interesting, as they have either non-localised type of chiasmata, or centric type and the number of chiasmata per bivalent is low. Among those possessing leaves of filiform type, A. schoenii and A. jacquemontii have simplest type of karyotype, while A. griffithianum possesses a complex karyotype on account of interstitial satellites.
Morphologically *A. jacquemontii* is very much close to *A. kaghoori* which is substantiated to some extent with karyological and meiotic data also. *A. griffithianum* of this section shows an advanced type of karyotype since four chromosomes possess interstitial satellites.

Section: Aniziridium

The members of this section exhibit karyotypes which range from very primitive as in *A. consanguineum* to a highly advanced one as in *A. victorialis*, with an intermediate type found in *A. stracheyi* among the diploids of this section. Nasir (1973) regarded *A. stracheyi* as a synonym of *A. consanguineum*. This cannot be karyologically substantiated because the two have different karyotypes. An interstitial satellite in a pair of chromosomes, however, is common to both. The two vary in their meiotic data as well. The two tetraploids of Aniziridium, *A. biandum* and *A. thomsoni* having bulb-scales membranous, stamens longer than the perianth, and which otherwise resemble much morphologically are regarded as synonyms of *A. caeruleinum* (Nasir, 1973). The two, however, vary in the details of their karyotypes. In *A. thomsoni* the 1st pair is highly heteromorphic. Total chromatin length and IF also vary between the two, but in both the chromosomes of the last pair possess satellite at the end of their short arm. *Allium victorialis* of the same section, with the outer scales of the bulb of reticulated fibres and stamens longer than the perianth, has a characteristic karyotype. The
karyotype is asymmetrical and polymorphic with an interstitial satellite on the long arm of the chromosome pair 1 suggesting it to be an advanced taxon of this section. Another group of the same section with the outer scales of the bulb of reticulated fibres but stamens shorter than the perianth, are A. humile and A. tuberosum. Allium tuberosum seems to have evolved from A. humile after polyploidization followed by chromosome repatterning, which becomes evident since A. humile has two satellited chromosomes and forms normal bivalents, while A. tuberosum has four satellited chromosomes and meiosis is characterised by multivalent formation.

Section: Molium

The karyotype of A. sphaerocephalum of this section resembles members of Rhizinidium group in possessing long-sized and satellited chromosomes.

Cultivated Alliums

Among the cultivated Alliums the karyotype of A. saccalonicum seems to be very primitive. Except for 2 M chromosomes, the karyotype is very much similar to A. cepa var. cepa. Nasir (1975) regarded A. saccalonicum as synonym of A. cepa var. cepa, which can be substantiated from cytological data as well.

The two varieties of A. cepa are karyologically very different from each other. The basic set of tetraploid does not tally with that of the hexaploid, suggesting that
the hexaploid has had its origin from some different karyological source. Hexaploid has an advanced karyotype, possessing st- and t- chromosomes. Meiotically the tetraploid behaves abnormally indicating its unstable nature. The karyotype of A. aestivum is primitive for centromeric positions but for the possession of interstitial satellites, its karyotype seems to be advanced.

Members of section Schoenoprasum have total chromatin length comparatively less than others except in a population of A. schoenoprasum. Total form percentage varies from 40-43.55 in this section indicating the position of centromere mostly towards the centre of chromosome. The largest chromosomes are found in Anthiridium section. Total form percentage in this section varies from 36.33 to 44.72, indicating that chromosomal repatterning has played a significant role in this section for speciation. Chiasmata number per bivalent is also higher than in Schoenoprasum group. The member of Molium section resembles much karyologically with the members of Anthiridium in having long chromosomes with satellites. Cultivated ones are also possessing long chromosomes like in the members of Anthiridium or Molium sections. Cultivated Allium possess advanced karyotypes. Except A. ascalonicum and A. cepa var. cepa, which resemble karyotypically, all the others and even the taxa of the same species do not show karyological resemblance with each other.
From detailed karyological investigations and meiotic behavior, cryptic structural changes, chromosomal repatterning in diploids, with or without increase in ploidy either at auto- as in *A. griffithianus*, *A. tuberosum*, *A. porrum* (Rees) or at allo-level as in *A. blandum* or *A. thomsoni*, seem to have played considerable role in this genus for speciation.

The fragrant character, umbellate inflorescence and predominant vegetative mode of propagation seem to represent a common gene pool in all the species of the genus.

**FAMILY: ARACEAE Juss.**

The aroids constitute more than 100 genera and perhaps 1000 species (Hooker, 1894) around the world, being especially abundant in tropical countries. According to Hende (1933) the family comprises 110 genera with nearly 1800 species. Azy Shaw (1973) reported 115 genera and 2000 species distributed in tropics and temperate regions, with 92% tropicals. The members have a variety of vegetative habits. Only two genera are reported from Kashmir. At present only one genus has been worked out.

**Arismum Mart.**

The genus has 150 species distributed in East Africa, tropical and temperate Asia, and North America to Mexico (Azy Shaw, 1973). Nine species occur in the Western Himalayas.
Only three are reported from Kashmir (Stewart, 1972). The corm of *Arisaema* species is violently acid, amylaceous and nutritive. Root is used to kill worms which infest cattle in the rains.

Presently two species have been worked out.

**A. wallichianum** Hook.

Grows abundantly in Yus and Burgah area between 1900-2000 m.

Chromosome number 2n=26 was determined from tapetal cells as well as root-tips (Figs. 223, 227). Chromosomes fall into thirteen pairs (Fig. 226). Karyotype consists of 6M+16m+4sm chromosomes falling into two size categories I and J. Some of the pairs in the karyogram especially 1st and 3rd seem to be heteromorphic. Total chromatin length is 68.67 μ and TF% is 43.46. Chromosome size ranges from 4.41 to 2.02 μ and 5% is 45.80. Detailed karyotypic formula is 6 1m+6Jm+8Jm+4sm.

**A. jacquemontii** Bl.

Fairly common plant distributed at 2000-3000 m.

Root-tip mitosis revealed 2n=32 (Fig. 228). Karyotype consists of 12M+22m+12sm+6st chromosomes falling into three size categories I, J and K. They could be classified into 25 pairs (Fig. 229). Total chromatin length is 141.75 μ and TF% is 39.11. Chromosome size ranges from 4.41 to 1.94 μ and 5% is 43.99. Detailed karyotypic formula is 6 1m+4 I+4 1sm+6Jm+6Jm+6Km+6Km.
DISCUSSION

The present count of 2n=32 for *A. jacquemontii* is in conformity with the previous reports (cf. Table I) but that of 2n=26 for *A. malichianum* is different from the findings of Malik (1961a, b) and Mehra and Sachdeva (1976d) who observed 2n=28. However, this finding coincides with the reports of some other workers (cf. Table I). Karyological observations indicate that *A. jacquemontii* is an allo-tetraploid. These studies support the base number for the genus as x=13.

FAMILY: AMARYLLIDACEAE Jaume St.-Hil.

A medium sized family, widely distributed throughout the world, abundant in temperate and warm temperate regions but rare in tropics. Various authors hold different views regarding the number of genera and species belonging to it. According to Airy Shaw (1973) the family comprises 85 genera and 1100 species. The family includes a large number of ornamentals. Survey of the literature reveals that the family is fairly investigated cytologically. One introduced species in Kashmir has been presently worked out.

*Nerine* herb.

The genus comprises 30 species distributed in South tropical and South African region. It has an
Nerine lutea dubia

Root-tip mitosis revealed 2n=27 (Fig. 231). Chromosomes fall into 9 groups (Fig. 231), each group of three chromosomes. Karyotype consists of 6m+12st+9t chromosomes falling into four size categories C, E, F and G. Chromosomes of the group 4 show slight asymmetry with respect to their size and arm-ratio. Total chromatin length is 297.79 μ and TFe is 23.07. Chromosome size ranges from 7.22 to 7.35 μ and 5% is 36.36. Detailed karyotypic formula is 6Cm+3E+3E+6F+3F+3G+3G.

DISCUSSION

This species has been worked out for the first time. The base numbers for the genus are x=11, 12 (Darlington and Wylie, 1953), but the present species suggests a different base number x=9. Karyotypically the species seems to be advanced as a majority of the chromosomes are subterminal.

FAMILY: IRIIDACEAE Juss.

Hooker (1894) reported 57 genera and about 700 species in this family. Lawrence (1951) estimated 56 genera and 1200 species. According to Kendle (1953) the family comprises 60 genera and about 1050 species.
Shaw (1973) reported 60 genera embracing 800 species. The distribution is all over the globe except in the coldest regions. The center of distribution is in Africa. Phylogenetically the family was treated by Diels, Wettstein and by Bessey to have evolved from the Amaryllidaceae—a view influenced largely by the inferior ovary being common to both (cf. Lawrence, 1951). Hutchinson (1939) has divided the family into 11 tribes. Only two tribes have been presently studied.

**Tribe: Irideae**

*Iris* is the only genus presently investigated.

**Iris** Linn.

The genus constitutes 300 species (Shaw, 1973) met with in North-temperate regions. Sixteen species are found in India and about 9 species occur in the Western Himalayas. At present 4 species have been worked out.

**I. ensata** Thunb.

It is a perennial herb. Isolated patches are found in ravines at an altitude of 1600-1800 m. The plants have fodder value.

Two cytotypes have been discovered with 2n=40 (Fig. 236) and 2n=60 (Fig. 238). The latter cytotype is quite rare.
PMC's of the cytotype (2n=40) showed abnormalities. Interlocking of chromosomes were seen at diplotene (Fig. 232). Secondary association of chromosomes were also observed (Fig. 234). Early separation of bivalents and lagging chromosomes were observed at T1 (Fig. 235). Equal distribution of chromosomes at T1 (Fig. 233) showed that the laggards ultimately reach the pole.

Karyotype of 2n=40 consists of 4M+16m+12sm+8st chromosomes (Fig. 237) falling into four size categories H, I, J and K which could be arranged into 20 pairs. Total chromatin length is 122.26 μ and TF% is 36.31. Chromosome size ranges from 3.66 to 1.73 μ and 5% is 30.32. Detailed karyotypic formula is 6H^4+4I^4+4J^8m+4K^8t+2H^6+8J^6m+2J^8t+2K^6+6K^8t.

Karyotype of the taxon with 2n=80 (Fig. 238) consists of 16M+26m+32sm+48st chromosomes falling into three size categories H, J and I and arranged into 20 groups of four chromosomes each (Fig. 239). Chromosomes of 3rd and 5th pair are satellited at the end of short arm (Fig. 239). Total chromatin length is 277.32 μ and TF% is 40.46. Chromosome size ranges from 5.33 to 2.26 μ and 5% is 42.40. Detailed karyotypic formula is 8H^4+8I^4+2I^8m+12J^6m+4J^8t. This taxon appears to be an auto-tetraploid.

I. kashmiriensis Baker

This species grows abundantly in the graveyards.
in Kashmir. The flowers are white and fragrant.

At diakinesis bivalents showed secondary associations and univalents were also seen (Fig. 240). Non-congregation of chromosomes at M, was also observed (Fig. 241). Counting was not possible at meiosis.

Root-tip mitosis, however, revealed 2n=44 (Fig. 242), falling into 22 pairs (Fig. 243). Karyotype consists of 6M+6m+14sat+18t chromosomes, belonging to four size categories F, G, H and I. Second pair of the karyogram (Fig. 243) has a satellite at the end of short arm. Total chromatin length is 222,66 μ and TF is 20.89. Chromosome size ranges from 9 to 3.4 μ and S% is 37.77. Detailed karyotypic formula is 2M+2G+6C+2H+6H+4H+6I and 4M+4I, 1st+8 1t.

L. germanica L.

This is also common in graveyards but a few escapes were noticed in the ravines. Flowers are of lilac colour.

PMC's revealed n=24 at M, (Fig. 244). Early disjunction of chromosomes was noticed in some bivalents. Chiasmata were mostly localised at one end of bivalent.

Root-tip cells revealed 2n=48 (Fig. 245), and the chromosomes could be arranged into 24 pairs (Fig. 246). Karyotype consists of 8M+2G+10C+2H+4H+4H+1H and 4M+4H. The chromosomes of the 3rd and 10th pair (Fig. 246) possess satellite at the end of the short arms. Total chromatin
length is 235.73 μ and TF% is 27.16. Chromosome size ranges from 9.33 to 3.85 μ and 5% is 41.37. Detailed karyotypic formula is $4F^M + 20M^M + 26Sm + 26St + 2H^M + 4H^Sm + 14St + 4St^2 + 4M^t + 4Sm^t + 8St^t$.

*i. kumaonensis* well.

This dwarf bearded iris grows in open grassy lawns at 2000-3000 m.

Root-tip mitosis revealed $2n=24$ (Fig. 247). The chromosomes could be arranged into 12 pairs (Fig. 248). Karyotype consists of $2M+12m+6Sm+4St$ chromosomes falling into 5 size categories F, C, m, t and J. Total chromatin length is 123.8 μ and TF% is 37.02. Chromosome size ranges from 6.13 to 2.66 μ and 5% is 33.17. Detailed karyotypic formula is $2M^M + 20M^m + 2St^m + 2St^t + 4M^t + 2Sm^t + 2St^t + 2M^t$.

**Tribe: Croceae**

**Croceus**

The genus according to A. A. Shaw (1973) comprises 75 species, distributed in Europe and Mediterranean regions. Only one species has been investigated presently.

**Croceus sativus**

The stigmas of this plant are collected in commercial quantities for use in the preparation of saffron dye, used for colouring dishes, liqueurs etc.

Root-tip mitosis revealed $2n=24$ (Fig. 249) which
could be arranged into 12 pairs (Fig. 250). Karyotype consists of $2n$=$8m+8s+6st$ chromosomes falling into five size categories $F$, $G$, $H$, $I$ and $J$. Second pair possesses a satellite at the end of long arm and third pair of the karyogram (Fig. 250) was found to be heteromorphic. Total chromatin length is 110.66 $\mu$ and IFA is 31.92. Chromosome size ranges from $9.33$ to $2.8$ $\mu$ and $S$ is 20.01. Detailed karyotypic formula is $2F^{sm}+1G^{sm}+26st+1I^{sm}+2H^{sm}+24st+6I^{st}+4I^{st}+2I^{st}+2H^{st}$.

**DISCUSSION**

Present investigations cover four species of *Iris* and one species of *Crocus*. Detailed meiosis has been studied in *Iris ensata*.

*Iris*: Two cytotypes of *Iris ensata* ($2n=40$, $2n=60$) have been presently observed. The most dominant cytotype is $2n=40$. The other cytotype $2n=60$ grows intermixed with $2n=40$. The count of $2n=40$ for *I. ensata* confirms the previous reports (cf. Table 1). The present count of $2n=44$ for *I. kashmiriana* is in agreement with the reports of some previous workers and also with one of the numbers of *Mitra* (1936) $2n=44$, but differs from his other reports of $2n=24$, $2n=48$. The count of $2n=48$ for *I. germanica* is in conformity with one of the numbers of Simonet (1929, cf. Fedorov, 1969) and of some other workers, but is at variance with other reports (cf. Table 1). The species
appears to be cytologically variable. The present count of \( 2n=24 \) for \( I. kumaonensis \) is in conformity with previous reports (cf. Table 1). La Cour (1945, cf. Fedorov, 1969), however, reported two numbers in this species \( 2n=22, 24 \). Desynapsis of various grades was observed in the three species. \( Iris ensata \) was medium strong desynaptic, while \( I. keamiriana \) and \( I. germanica \) were weakly desynaptic.

In 1926 Delauney established a correlation between morphological characters of the plant and the karyotype in \( I. caucasia, I. reticulata, I. iberica \) and allied species. Simonet (1932, 1934) noted differences among certain species of \( Iris \) with respect to the length and centromere position of their chromosomes and suggested an evolutionary scheme for the karyotype with special reference to the bearded irises. He concluded that the true bearded irises occupy a central and primitive position from which other groups originated through a gradual change from a symmetrical karyotype with metacentric chromosomes to an asymmetrical karyotype, culminating in the section Oncocyclus, with entirely acrocentric chromosomes. Westergaard (1935) made a karyotype analysis of Danish and Central European forms of \( I. spuria \) and concluded that geographical races of this species are karyologically different with respect to the morphology of individual chromosomes.

In the present study a dwarf bearded iris, \( I. ensata \), has been found to possess mostly metacentric chromosomes.
The three other species have mostly subterminal chromosomes, and in these satellitization is common. A polyploid clone, also reported in *J. ensata*, may have evolved from a cell in which endomitosis duplicated the genomes followed by some chromosomal repatterning, as the basic karyotype of cytotype $2n=80$ varies from that of $2n=40$. Sharma and Sharma (1961a) observed along with the normal complement, variation in number and structure of chromosomes in the somatic tissues and suggested that such somatic variations may play an important role in speciation, either directly through vegetative means or by their persistence in germ cells.

Simonet (1934) observed intraspecific polyploidy in some species and occurrence of aneuploids also. Löve and Löve (1961) reported $2n=108$ in *J. versicolor*. The various chromosome numbers ($2n$) recorded for different species (*vide* Darlington and Wylie, 1935 and Löve and Löve, 1961) are 16, 17, 20, 21, 22, 24, 28, 30, 31, 32, 33, 34, 36, 40, 42, 44, 48, 50, 54, 56, 70, 72, 84, 88, 103 and 108. And the base numbers suggested for the genus are $x=7, 8, 9, 10, 12$ etc. (Darlington and Wylie, 1935). All these data together with the present investigations suggest that the genus is cytologically dynamic and both polyploidy and aneuploidy accompanied with structural changes have played a significant role in the evolution of various species of this genus.
Crocus: Present count of 20-24 for Crocus sativus is in agreement with most of the other workers (cf. Table I). However, some others have observed different numbers.

FAMILY: ORCHIDACEAE Juss.

It is one of the most highly evolved and successful families of the Monocots. It is widely distributed in tropics and subtropics and also in temperate regions but rare in subarctic. Within the tropics orchids form an important feature of the vegetation, living chiefly as epiphytes. In India, orchids have maximum concentration in the Eastern India and the Western Ghats. They are found occurring from the plains of tropical to the temperate Himalayas. Epiphytes mainly occur in the Eastern Himalayas, Eastern India and the Western Ghats. Majority of the terrestrial species grow in the western Himalayas (cf. Mehra and Vij, 1974). Garay (1960) reported 800 genera and 30000 species, Schultes and Pease (1963) 35000 species, Cronquist (1968) about 19839 species, Airy Shaw (1973) estimated 735 genera and 20000 species and Goods (1974) estimated 750 genera and 20000 species.

The orchids met in Kashmir are all terrestrial. They are not abundant. Stewart (1972) listed 18 species from Kashmir.

Dressler and Dodson (1960) divided the family into
four tribes, of which only 2 taxa falling into the tribes Cypripedieae, Neottieae and Orchideae have been presently worked out.

Tribe: Cypripedieae

Only one taxon of this tribe has been investigated.

_Cypripedium_ L.

The genus constitutes 50 species, distributed in North temperate regions (Airy Shaw, 1973). Two species are reported from Western Himalayas. Only one is met in Kashmir (Stewart, 1972).

_C. cordigerum_ Don.

Hare in the forests of valley at an altitude of about 2000 m.

Root-tip mitosis revealed 2n chromosomes (Fig. 231) which could be grouped into ten pairs (Fig. 232). A number of populations were karyologically scrutinised and all revealed a similar karyotype, consisting of 12d+6m+2st chromosomes falling into two size categories D and E. Chromosomes of the 3rd pair (Fig. 232) are secondarily constricted in the short arm. Total chromatin length is 251.32 µ and IF% is 43.01. Chromosome size ranges from 17.64 to 11.02 µ and 5% is 62.35. Detailed karyotypic formula is 4D²+2D²+6E²+4E²+2St.
Tribe: Neottioideae

Three genera of this tribe have been investigated.

Epipetis Br.

The genus constitutes 24 species met in the North temperate regions, and South to tropical Africa, Thailand and Mexico (Ary Shew, 1973). Only three species have been reported in North West Himalayas (Hooker, 1894; Stewart, 1972).

E. consimilis Wall.

The plant is uncommon in the valley.

HMC's revealed n=20 at M₁ (Fig. 233). Four bivalents were much larger than the rest and showed distal chiasmata. Small bivalents exhibited early disjunction and M₁ was normal (Fig. 234).

E. latifolia Sw.

It grows abundantly in Pahalgam and Sonamarg areas.

HMC's revealed 2n=40 at M₁ (Fig. 235).

Root-tip mitosis also revealed 40 chromosomes (Fig. 236) which could be arranged into twenty pairs (Fig. 237). Karyotype consists of 12M+10m+8sm+8st+2T+2T chromosomes, falling into six size categories F, G, I, J, K and L. Total chromatin length is 132.79 μ and 1% is 32.30. Chromosome size ranges from 8.67 to 1.02 μ and 5% is 11.75. Detailed karyotypic formula is
E. royleana Lindl.

It is quite common at an altitude of 2000-3000 m.

PMC's revealed 2n bivalents at $M_I$ (Fig. 258). Small bivalents showed false associations. Rest of the meiotic course was normal.

Root-tip mitosis revealed 40 chromosomes (Fig. 259), which could be arranged into 20 pairs (Fig. 260). Karyotype consists of 6$F$+8$g$+6$s$+8$t$+12$t$ chromosomes falling into 6 size categories F, G, H, I, J and K. Total chromatid length is 186.47 $\mu$ and $TP$ is 27.62. Chromosome size ranges from 9.55 to 1.61 $\mu$ and $S$ is 16.83. Detailed karyotypic formula is $2F^{sm}+2G^{st}+2H^{st}+2I^{sm}+2J^{Gt}+8K^{Gt}+4K^{gt}+2K^{gt}+2K^{gt}$.  

Neottia Coeii.

According to Airy Shaw (1973) the genus comprises 9 species, distributed in Eurasian region. Presently 2 species have been worked out.

N. insularis (Du.) Beauverd.

PMC's revealed 2n=42 at early $M_I$ (Fig. 261).

N. lilioides Lindl.

PMC's revealed n=2 at late $M_I$ (Fig. 262).

Root-tip cells also showed 2n=42 (Fig. 263).
Goodyera R. Br.

The genus comprises 40 species, distributed in Euroasian region, tropical Asia, Australia, Polynesia and temperate North America (Airy Shaw, 1973). Only one species is reported from Kashmir (Stewart, 1972).

C. repens Br.

Root-tip mitosis revealed 2n=30 (Fig. 264).

Tribe: Orchideae

Only one taxon of this tribe has been worked out.

Orchis Linn.

Airy Shaw (1973) reported 35 species in this genus distributed in Madeira, temperate Euroasia to India and South West China. The only species presently investigated is O. latifolia.

O. latifolia Linn.

It grows in patches at an altitude of 1800 to 3000 m, usually near the damp places.

Two cytotypes have been discovered. Panjaloo populations revealed 2n=30 in the root-tip cells (Fig. 266). Sonamarg populations showed 2n=40 (Fig. 265). At Baltal both the cytotypes grow intermixed. Morphological variations in the two cytotypes are depicted in Table V and Fig. 267. Cytotype 2n=30 is giant sized as compared to the one with 2n=40.
## Table V

**Analysis of various characters of two races of *Oxalis latifolia***

<table>
<thead>
<tr>
<th>Characters</th>
<th>2n=40</th>
<th>2n=60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height</td>
<td>20-45 cm</td>
<td>50-60 cm</td>
</tr>
<tr>
<td>Leaf:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>numper per plant</td>
<td>6-15</td>
<td>10-35</td>
</tr>
<tr>
<td>length</td>
<td>5-15 cm</td>
<td>8-30 cm</td>
</tr>
<tr>
<td>breadth</td>
<td>0.5-2 cm</td>
<td>1-4 cm</td>
</tr>
<tr>
<td>stomatal size</td>
<td>23x25 μ</td>
<td>33x32 μ</td>
</tr>
<tr>
<td>Inflorescence length</td>
<td>5-10 cm</td>
<td>15-23 cm</td>
</tr>
</tbody>
</table>