OBSERVATIONS

Tribe VERNONIEAE

*Centratherum phylloleaenum* (DC.) Benth.

A very variable annual, with spreading branches and elliptic leaves. The characteristic feature is the presence of outer leafy involucral bracts. The species is common in the foothills of S. India, ascending up to 1,000 m. or more.

Flowers: September - November.

Chromosome number was determined from pollen mother cells and 9 medium sized bivalents were observed at diakinesis (Fig. 1). One bivalent was found to be associated with the nucleolus. At A₁ the chromosomes separated regularly to each pole. Further course of meiosis was normal and 98% of pollen were viable. The species has been cytologically investigated for the first time. Turner and King (1964) reported n=16 for the Mexican species *C. punctatum* Cass.

*Vernonia monosia* DC.

A showy small tree with purple scented flowers and tomentose leaves. It is found in the Western Ghats, from Coorg and Bababudan hills, spreading towards Nilgiris, usually above 1,200 m.

Flowers: August-September.
Meiotic studies revealed it to be a hexaploid on the base number 9. At diakinesis 27 bivalents were discernible (Fig. 2). The course of meiosis was regular and 97% of pollen were fertile. This is a new report for the species.

**V. revoluta** Buch.-Ham.

A perennial woody-rooted herb, branched from the base, with slender angled and grooved stem, found in Western Himalayas.

Flowers: June-July.

The present cytological record of n=9 is in line with the earlier reports by Turner and Lewis (1965), Mehra *et al* (1965) and Shetty (1967). Meiosis was regular and 98% of pollen were stainable. The chromosomes are of medium size.

**V. cinerea** (Linn.) Less.

A herbaceous annual with pink or lilac flowers and white silky pappus, found commonly along roadside or in open forests. The shape of the leaves is variable. This herb grows under varying conditions of moisture and soil. It is an abnoxious weed. During monsoons the plant is erect, reaching 1 m. in height, while after the monsoons it becomes prostrate and diffuse in habit. It is found upto 2,500 m.

Flowers: August-November.
The present report of n=9 is in line with the numerous reports on the species (see Table II). Meiosis was regular and 99% of pollen fertile. The chromosomes are of medium size. Recently Gupta (1969) noted some ecotypic differentiation in the species.

V. noveboracensis Willd.

A perennial with dark purple heads and purplish pappus, cultivated in gardens as an ornamental. Flowers: June-August.

The finding of n=9 confirms the only previous report on the species by Mehra et al. (1965). Bivalents were of ring or rod type with terminalised chiasmata. Meiosis was normal and 99% of pollen fertile. The chromosomes are of medium size.

A perusal of the literature reveals that during recent years several basic chromosome numbers have emerged in the genus Vernonia. African species are known with x=9 and 10 (Turner & Lewis, 1965). There are American species with n=16, 17 and 20 (Turner and Lewis, 1965). Counts for the wide-spread pantropical taxon V. cinerea have been reported from three continents as n=9 (Africa; Miege, 1960; Turner and Lewis, 1965; Asia: Chuang et al., 1962; Grant, 1953; Mehra et al., 1965; North America: Turner and King, 1964). All the species investigated by the present author have the basic number 9. V. monosis, a tree, is a hexaploid on the base number 9.
Tribe EUPATORIEAE

Adenostemma lavenia (Linn.) Kuntze.

An erect annual herb with white flowers and very variable leaves. It is common in damp forests, along the banks of streams, ascending upto 1,000 m. The plant possesses medicinal properties.

Flowers: August-September.

The present report of n=10 confirms the previous reports by Gajapathy (1962) and Mehra et al (1965).

Meiosis was regular and 97% of pollen fertile. Chromosomes are of medium size.

Ageratum connoides Linn.

A softly hairy annual, with pale blue flowers, found in plains and hills, common in damp places and in forest undergrowth. It is a troublesome weed in Tea, Coffee and other plantations. The weed grows abundantly as a herbaceous undergrowth in the orchards. The present study on the populations growing in Nilgiri hills and Dehradun revealed the existence of two intraspecific races, a diploid and a tetraploid (Fig. 3). The diploids are more robust and show vigorous growth compared to the tetraploids. There is a distinct altitudinal difference in their distribution. The diploids are confined to the hills between 1,000 and 2,200 m., and the tetraploids are common in the plains ascending upto 900 m. Nevertheless in foot-hills both the populations grow together.
Flowers: March-September.

Diploid

At diakinesis 10 bivalents were discernible. Though meiosis was regular in most of the cells, occasionally, non homologous associations were observed at diakinesis (Fig. 4). At A reflection laggards were noticed in some cases (Fig. 5). Pollen fertility was 96%. Chromosomes are of medium size.

Tetraploid

Twenty bivalents were observable at diakinesis. Nonhomologous association was observed in 40% of cells analysed (Fig. 6). However, further course of meiosis was regular and 95% of pollen were fertile. Chromosomes are of medium size. Compared to the diploid a slight reduction in size of the chromosomes was noticed.

This widespread weed has been reported as tetraploid from India (Mitra, 1947) and Africa (Turner and Lewis, 1965). Koul (1964) and Mehra et al (1965) have also recorded the diploid taxon from this country. More recently Gupta (1969) reported diploid and tetraploid taxa from N. India.

Eupatorium glandulosum H.B.K.

An introduced herb from Mexico. Often decumbent, glandular-pubescent; leaves ovate, coarsely toothed; heads white. The species was not recorded by Hooker (1832). Now it is common in Darjeeling hills of the Eastern Himalayas,
and Nilgiri and Pulney hills of S. India.

Flowers: September-November.

Meiotic studies revealed it to be a triploid on the basic number 17. Fig. 7 shows 1 trivalent, 5 bivalents and 38 univalents at diakinesis. Thirty five to forty five univalents were commonly noticed at diakinesis and M. Three to four univalents were associated with the nucleolus at diakinesis. At A, 70-80% of cells showed abnormalities such as laggards, delayed separation, and irregular distribution of chromosomes. Pollen stainability amounted only to 30%. Chromosomes are of medium size.

Holmgren (1919) has shown it to be an apomict on embryological investigations. The present report of 2n=51 is in line with the previous reports by Grant (1953) and Mehra et al (1965).

E. odoratum Linn.

A West Indian species, recorded as a rare plant by Hooker (1862). At present it is one of the commonest plants in South India. The plant is shrubby, pubescent, leaves ovate, heads white to blue. In Kerala it is often used as fish poison.

Flowers: March-June.

This was also found to be a triploid with 2n=51 (Fig. 8). The present report is not in line with the only cytological report on the species by Ghosh (1961) who reported 2n=58. Meiosis was found to undergo a very
disturbed course. Bivalents and multivalents were rare and total asynapsis was noticed in majority of the cells. At $M_{II}$ a few chromosomes remained off the metaphase plates and the distribution of the chromosomes was unequal at $A_{II}$. Micronuclei were observed at the tetrad stage (Fig. 9) in about 20-30% of the microsporocytes. About 30% of pollen were fertile.

The genus *Eupatorium* is widespread in the tropical and subtropical regions of the world. There are about 400 species, chiefly American (Hooker, 1882). Chromosome counts for about 60 taxa are known (Turner et al., 1962). Many species are known with $n=10, 15, 17, 20$ and 25. Two annuals *E. sinclairii* and *E. guadalupense* are known with $n=4$. According to Grant (1953) species with 5 and 4 might have given rise through successive allopolyploidy to those taxa with basic numbers of $x=9, 10$ and 17.

**Tribe ASTEREEAE**

*Solidago virg-aurea* Linn.

A tall, graceful, perennial herb with heads on short axillary stalks, found in grassy and wooded hill-sides of temperate Himalayas.

*Flowers:* June-September.

The present report of $n=9$ is in line with the numerous earlier reports (see Table II). One of the nine bivalents was observed to be associated with the nucleolus at diakinesis. Meiosis was normal and 99% of pollen were
fertile. Chromosomes are large in size.

Chromosome numbers of Solidago have been reported by Carano (1921), Goodwin (1937), Love and Love (1948) and others. Beaudry and Chabot (1959) made a comprehensive investigation on the cytotaxonomy of twenty five species of Canadian Solidago. So far, only one basic number, x=9, has been found in the genus. Somatic chromosome numbers 18, 36 and 34 have been recorded.

Huziwara (1962) made karyotypic studies of three subspecies of S. virg-aurea. On the basis of chromosome number determinations and observations of karyotype on different species of Solidago he has concluded that the endemic Asiatic taxa of this genus have remained at a primitive level while the North American taxa have undergone rapid evolution.

 Dichrocephala bicolor (Roth) 

An annual weed with highly variable leaves. Flowers minute, inner yellow, outer white in discoid heads. Achenes flat and smooth. It is found in Himalayas and hilly places of South India.

Flowers: June-September.

Present report of n=9 confirms the previous report by Borgmann (1964). Two of the 9 bivalents were observed to be associated with the nucleolus at diakinesis. Meiosis was regular and 98% of pollen were fertile. Chromosomes are large in size.
Grangea madaraspatana (Linn.) Poir.

A common annual weed which grows prostrate on the ground in sandy places, sometimes common also in waste places, forming small patches. The herb possesses medicinal properties.

Flowers: Major part of the year.

This is a diploid. Nine bivalents were discernible at diakinesis. This confirms the previous report of Mitra (1947). Meiosis was regular and 97% of pollen were fertile. Chromosomes are of medium size.

Myriactis wightii DC.

A stiff annual weed with lyrate leaves and long-peduncled heads found in woods above 2,000 m in Nilgiri and Pulney hills.

Flowers: June-September.

At diakinesis 13 bivalents were discernible (Fig.10). Bivalents were of ring or rod type with terminalised and interstitial chiasmata. Meiosis was regular and 96% of pollen were fertile. Chromosomes are large in size. The species has been investigated for the first time.

M. nepalensis Less.

A most variable weed. This annual closely resembles M. wightii. Leaves lanceolate, heads in clusters on diverging stalks, convex, achenes flat and smooth.

Flowers: June-September.
This species also had \( n=18 \) which confirms the previous report by Mehra et al (1965). Though meiosis was found to undergo a regular course, stickiness of chromosomes was noticed at diakinesis (Fig.11) and at \( M_1 \). However, 95% of pollen were fertile. Chromosomes are fairly large in size.

*M. wallichii* Less.

A pubescent annual herb which closely resembles the former two species. But it is more slender, heads smaller on slender stalks. Hooker (1882) remarked "I can scarcely think this more than a slender small-headed form of *M. nepalensis*, but if more than one species is to be kept, this must be one of them."

Flowers: June-September.

At diakinesis 18 bivalents were discernible (Fig.12). This confirms the previous report by Mehra et al (1965). Chromosomes are large in size as in the previous two species. Meiosis was regular and 98% of pollen were stainable.

*Bellis perennis* Linn.

This is commonly grown in gardens as an ornamental. Often it escapes to the lawns. In Srinagar, the plant was found to spread widely to such an extent that the species appears to have become a part of the local flora.

Flowers: June-July.

The present report of \( n=9 \) is in line with the previous reports on the species. Meiosis follows regular
course with 97% of pollen fertile. Chromosomes are large in size.

*Callistephus chinensis* Nees.

This ornamental plant which is a native of Asia, yields many races of well-known annuals for the gardens. The rays become greatly multiplied and show a wide range of variation in size, shape and colour. In India it is cultivated as a winter annual. Flowers: February-March.

At metaphase 9 bivalents were discernible (Fig. 13). They were of ring and rod type with terminalised chiasmata. A 1 was regular and 9:9 distribution was observed (Fig. 14). Ninety seven percent of pollen were stainable. Vaarama and Sulkinoja (1958) reported n=18, 19 for the species. The present record is the first report of a diploid taxon.

*Aster mollisculus* Wall.

An erect perennial with woody root stock and variegated "flowers". The species is a good potential ornamental plant. Grierson (19 ) in his recent revision of the Himalayan *Aster* noticed considerable variation in indumentum and pappus in the species. The specimens from Northern side of the Himalayas tend to be glabrescent with stems sparsely pubescent and leaves glabrous except for ciliate margins. Around Simla and Kumaun, however, the plants are regularly pubescent except in var. *minor*. The pappus is usually double in the southern population, but simple in the northern
with the exception of some populations of Kashmir.

The species has frequently been confused with *Heteropappus altaicus*. But it can be readily distinguished by its stems which regularly bear ovate scale-like leaves at the base. It also differs in having the disc corolla lobes of regular size and not unequal as is the case in *Heteropappus*.

The species is not common. It is found on damp rocky slopes and open cliff faces. Flowers: June-September.

Meiotic studies revealed this to be a diploid with \( n=9 \) (Fig. 15). This is a new report. Meiosis was regular and 98% of pollen were fertile. Chromosomes are large in size.

*A. thomsoni* Clarke

An erect laxly branched rhizomatous herb with large and beautiful "flowers" found in the woods of alpine zones of Himalayas. Though presently not grown in gardens, the species was in cultivation before the end of last century. According to Grierson (19 ). *A. thomsoni* nanus of gardens is a low growing taxon of this species. With *A. amellus*, *A. thomsonii* was one of the parents of the well known garden hybrid *A. x frikartii*.

This species is easily confused with *A. peduncularis*. There are, however, several features by which it can be readily distinguished. The leaves of *A. thomsonii* are
usually less sharply toothed and are sessile, its disc corollas are only about 3.5 mm long and its pappus only half as long as the disc corollas. Assuming that these two species are directly descended from the same ancestral stock and that their close similarity is not due to convergence, the pappus of *A. thomsonii* may be homologous with the outer series of setae of *A. peduncularis*, the inner series having entirely disappeared.

Flowers: July-September.

The present material studied from the populations in Simla hills is a tetraploid on the base number 9. Mehra *et al* (1965) reported a diploid cytotype of the species from Mussoorie hills and Annen (1945) recorded a hexaploid. Fig. 16 illustrates the mitotic complement of the species (2n=36) from root-tip. Meiosis was regular with 98% of pollen fertility. Chromosomes are large in size.

*A. peduncularis* Wall.

(*= *A. asperulus* Nees.)

This is a perennial rhizomatous herb with attractive "flowers" which makes it a potential ornamental. As already stated, it is easily confused with *A. thomsonii* and the differences between them are set out in the description of the latter. Grierson (19 ) described two subspecies of this plant in his revision of Himalayan Asters.

Flowers: July-September.
Cytological studies of populations from Simla and Mussoorie hills revealed it to be a hexaploid with n=27. This confirms the report by Mehra et al (1965). Huziwara (1965) studied the karyotype of this species. Meiosis was regular and 97% of pollen were stainable. Chromosomes are large in size.

**A. linarifolius** Linn.

A stiff tufted leafy perennial cultivated in gardens for its beautiful flowers. Heads several, large, ray flowers violet, rarely white.

Flowers: June-August.

This is a diploid on the basic number 9. Fig. 17 illustrates the chiasma distribution at late diakinesis. Eight rings with terminalised chiasmata and one rod with a single chiasma were observed in the majority of cells. However, in some cells two rods were noticed. Meiosis was regular and 98% of pollen were viable. Chromosomes are large in size.

**A. amellus** Linn.

A perennial, cultivated in gardens in hill stations. It is a variable plant. Several well-marked garden forms are now cultivated.

Flowers: August-September.

Cytologically this is a well worked out species. A perusal of the literature reveals that it exists in many intraspecific forms. The present taxon is a hexaploid with
n=27. Meiosis was regular and 95% of pollen were stainable. Chromosomes are large in size. Huziwara (1962) studied the karyotype of three different races with 2n=18, 54 and 66. Somatic chromosome numbers ranging from 10 - 72 have been reported in different species of Aster. Majority of the cytologically known species contain 9 pairs of chromosomes or multiples of this number. This is an indication that the original basic number for this genus is 9. Haploid chromosome numbers 5 and 8 were found in some American species (Huziwara, 1958). Probably they have been derived from 9 by gradual reduction as in Crepis (Babcock and Cameron, 1934). Species with 6 and 7 are not known. Huziwara (1962) thinks that they had probably no survival value. He has determined three polyploid series for the American species of Aster. The first is based on 9, the second on 8 and the third on 5. The first and second series have three polyploid levels - tetraploid (2n=36, 32), hexaploid (2n=54, 48) and octaploid (2n=72, 64). The third series has only one polyploid level, that of tetraploidy (2n=20). Judging from the number of species which are polyploid, this mechanism appears to have played an important role in the evolution of species within the genus. The conclusion drawn by Arano (1965) with regard to the original base number of the genus, x=9, is in line with that of Huziwara. However, Turner (1962) does not believe in this view. According to him many species with a haploid chromosome number of 9 are derived from a diploid species with a
basic number of 10 through reduction in chromosome number. 

Huziware (1957a, 1957b) has observed that Japanese species mostly have a symmetrical karyotype and those of the New World have a more asymmetrical karyotype, a more advanced status according to the Lewitsky concept of karyotype evolution. This author (Huziware, 1962) has shown that the karyotypes of the European Aster are very similar to those of the Asiatic species, with large chromosomes and symmetrical karyotype. This led him to conclude that the European and Asiatic taxa have had their ancestral forms in common and have retained their primitive karyotypes with little chromosomal evolution.

**Brachvactis robusta** Benth.

A stout annual with obovate leaves and broad receptacles, found in the subalpine belt of the Western Himalayas. Flowers: June-August.

Fig. 13 shows 9 bivalents at diakinesis. The species has been reported for the first time. Meiosis was regular. A1 showed 9:9 distribution. Ninety eight percent of pollen were fertile. Chromosomes are of medium size. This is the first cytological report on the species.

**Erigeron bonariensis** Linn.

It is a highly variable herb, grows more or less gregariously in gardens, lawns and roadsides. It gives a characteristic appearance to the grassy ground by its erect
habit, closely set leaves and terminal panicles. It ascends from plains to hills at 2,200 m.

The present study on the populations growing in Simla hills has revealed the existence of two intraspecific races, a diploid and a hexaploid. Both the populations were found to grow side by side. However, no definite morphological characters could be detected to distinguish them in the field (Fig. 19).

Flowers: May-August.

Nine bivalents were discernible at diakinesis in the diploid. The hexaploid revealed 27 bivalents. Both the taxa had chromosomes of medium size. However, the hexaploid had significantly larger pollen mother cells (Figs. 20, 21). Both showed a high pollen fertility, 98% in the diploid and 95% in the hexaploid. The hexaploid has been reported earlier by Holmgren (1919) from South America.

*A. andryaloides* Benth.

A woolly perennial with spathulate leaves and woody root-stock, found in alpine hills.

Flowers: July-August.

This is a diploid on the base number 9. The species has been investigated for the first time. $M_I$ revealed 9 bivalents (Fig. 22) and at $A_I$ 9:9 distribution was observed. Meiosis was regular and 98% of pollen were viable. Chromosomes are of medium size.
E. alpinus Linn.

A perennial herb with pale purple ligules and yellow disc flowers, found in open hill sides and mountain paths of temperate Himalayas. This is a highly variable species with two extreme forms and various intermediates, namely, (a) with narrowly lanceolate, almost linear leaves, and (b) with broadly obovate leaves (Fig. 23).

Flowers: August-September.

Cytological studies of the two extreme forms did not reveal any chromosomal difference. Both the populations were diploid with n=9 (Fig. 24). This report confirms the earlier reports on the species. One of the bivalents was associated with the nucleolus. Meiosis was regular in majority of mother cells. However, stickiness and laggards (Fig. 25) were noticed occasionally. Pollen fertility was 95%. Chromosomes are of medium size.

E. multiradiatus Benth.

The small form of this species resembles E. alpinus. But the heads are larger, the ligules are very numerous and the involucres broad and villous. It is common in grassy hill-sides of the alpine regions of temperate Himalayas.

Flowers: August-September.

The present report of n=9 confirms the earlier reports of Zhukova (1964) and Mehra et al (1965). Meiosis was regular and 97% of pollen were fertile. Chromosomes are of medium size.
E. mucronatus DC.

A native of Mexico which has run wild in recent times. It is now a well established perennial which is commonly met throughout the hills of India. Apart from Darjeeling hills of Eastern Himalayas and Simla hills of Western Himalayas the author has collected it from the hills of Kerala from South India. The species is not included in any of the Indian floras. The plant has a specialised habitat. Mostly it grows on walls and slopes where it forms strikingly beautiful cover with numerous attractive asteroid "flowers". It is an excellent potential ornamental worth trying in the gardens in plains. The plant was tried in the University Botanic Gardens at Chandigarh (240 m.) and was found to do well.

Flowers: April-August.

Meiotic studies from populations growing in Darjeeling and Simla hills revealed that the plant is a tetraploid on the base number 9. Meiosis was found to undergo a mildly disturbed course, with univalents and laggards. Mehra et al. (1965) described various types of associations and aberrations occurring in the species. However, 70% of pollen were stainable. Chromosomes are of medium size.

Embryological investigations have shown that the species is apomictic and the embryo formation is parthenogenetic from unreduced eggs (Mehra et al., 1965). On the basis of cytological evidence they have regarded the species as a segmental allotetraploid.
In the genus *Eriaeron* there is found a polyploid series: \( n=9 \) (E. *alpinus*, E. *audryaloide*, E. *bonariensis*, E. *multiradiatus*), \( 2n=27 \) (E. *annuus*, E. *pseudoannuus*, Arano, 1965), \( 2n=36 \) (E. *mucronatus*), \( n=27 \) (E. *bonariensis*) with a basic number of \( x=9 \). Darlington and Wylie have included 16 also as the base number of the genus. Since most of the species have 9 or multiple of it, 9 should be considered as the original base number and species like E. *karvinskianus* (2n=36, 32, Darlington and Wylie, 1955) are euploid and aneuploid derivatives.

Arano's work (1965) has shown that the species of *Eriaeron* are karyotypically at a higher level than those of *Aster*.

*Conyza japonica* (Thunb.) Less.

An erect villous annual with sessile leaves and globose heads in terminal close corymbs.

Flowers: April-September.

The present report of \( n=9 \) confirms the previous report by Mehra et al. (1965). Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size.

*C. stricta* Willd.

The excessively fastigiatly branched and leafy habit of this species and its minute heads, distinguish it from all the other species.

Flowers: August-September.
Populations growing in Simla and Mussoorie hills of W. Himalayas and Nilgiri hills of South India were studied. All were diploid with n=9. This is in line with the previous reports by Mehra et al. (1965) and Shetty (1967). Two bivalents were associated with the nucleolus at diakinesis. Chromosomes are of medium size. Meiosis was normal with 97% of pollen fertility.

Tribe INULEAE

Blumea mollis (O. Don.) Merr.

This is a strong smelling species which can be distinguished from B. lacera to which it resembles by the small heads, purplish flowers and hairy achenes. It is found throughout the plains of India and the outer Himalayas ascending up to 1,500 m.

Flowers: February-May.

The species has been studied from the Simla hills and plains of Kerala state. All the populations were diploid. Eleven bivalents were discernible at diakinesis. One of them was associated with the nucleolus. Meiosis was mostly regular and 11:11 distribution was noticed at A1 (Fig. 26). However, meiotic aberrations such as bridges (Fig. 27), laggards and fragments were observed in 25% of mother cells analysed. Eighty five percent of pollen were fertile. Chromosomes are large in size. Turner and Lewis (1965) reported n=11 for the species from Africa.
A stout villous herb, corymbosely branched, found in tropical Himalayas. The species is common in waste places and near water channels. Flowers: March-May.

Diakinesis revealed 11 bivalents (Fig. 2d). One of them was associated with the nucleolus. Though majority of mother cells were found to undergo a normal course, bridges (Fig. 29) and laggards were noted occasionally. Ninety percent of pollen were stainable. Chromosomes are large in size. A recent report by Gupta (1969) of n=10 for the species seems to be erroneous.

**B. membranacea** DC.

A glandular annual with thinly membranous obovate leaves and numerous heads on slender glandular-hairy peduncles, found commonly along the coastal regions of Kerala. Flowers: June-August.

The species is a tetraploid on the base number 11. Fig. 30 shows 22 bivalents. Non-homologous association and bridges (Fig. 31) were observed occasionally. A slight reduction in size was noticed in this species compared to the diploid species of *Blumea*. Ninety two percent of pollen were fertile. The species has been investigated for the first time.

Though *Blumea* is a fairly large genus with about 60 species, very few species have been cytologically investigated. Chuang et al (1963) reported n=10 for *B. balsamifera*. 
Turner and Lewis (1965) reported \( n=11 \) for \( B. \) mollis. Mehra et al (1965) reported \( n=11 \) for \( B. \) lacera and \( B. \) membranacea. However, the presently worked out taxon of \( B. \) membranacea is a tetraploid \( (n=22) \). Gupta (1969) reported recently \( 2n=11 \) for \( B. \) lacera. He concluded that \( 2n=22 \) reported earlier for this species must have been for a derived polyploid taxon. He suggested basic numbers 5 or 6 in Blumea. However, even if his count of \( 2n=11 \) is correct and a taxon with this number at all exists, it can by no means be considered as diploid. It should essentially be a haploid taxon. Species with \( n=5 \) or 6 are unknown in Blumea. In the light of available information to-date, 11 is considered to be the probable base number of this genus.

\textit{Laqgera alata} (D.Don.) Sch.-Bip.

A stout rough leafy herb with conspicuously winged stems and drooping "flowers" found in the tropical Himalayas and Nilgiri hills. It is common in waste places and roadsides becoming gregarious in some places. The plant is used as a disinfectant.

Flowers: June-July.

Ten bivalents were observable at \( M_1 \). This confirms a recent report by Shetty (1967) for the species. Meiosis was regular with 98% of fertile pollen. Chromosomes are of medium size.
Sphaeranthus africanus Linn.

A slender glabrous fragrant herb found in swampy places.  
Flowers: April-May.

At diakinesis 10 bivalents were discernible (Fig. 32).  
Though meiosis was normal non-homologous associations and stickiness were observed in some PMCs. Ninety four percent of pollen were fertile. The genus *Sphaeranthus* has been investigated for the first time.

*S. indicus* Linn.

An aromatic herb with glandular hairy stem and branches. Flowers purple. It is commonly found in wet places. The plant is of medicinal value. Fresh flowering plant yields essential oil. Rind of fruit is used as fish poison.  
Flowers: August-October.

Diakinesis revealed 10 bivalents (Fig. 33). Meiosis was normal and 98% of pollen were fertile. Chromosomes are large. The species has been worked out for the first time.

Leontopodium alpinum Cass.

This species is very variable in habit, length and size of the involucriform leaves and woolliness. It is a perennial found in the alpine Himalayas.  
Flowers: May-August.

Fig. 34 shows 7 bivalents at diakinesis. Meiosis was regular and 98% of pollen were viable. Chromosomes are
of medium size. The present finding is a new chromosomal count for the species. Sakai (1935) recorded 2n=26. Sokolowska-Kulczycka (1959) and recently Korytkiewicz (1968) reported 2n=52 for this species. Along with the basic number 13 Darlington and Wylie (1955) placed 7 with a question mark for the genus. Most of the species of the genus Leontopodium are considered as diploids on the base number 13. (2n=26 : L. alpinum, L. kurilense, Sakai, 1935, 1934 cf. Darlington and Wylie, 1955; 2n=26 : L. faurei, L. japonicum, Arano, 1963). However, L. campestre is known to have the 2n number 49 (Sokolovskaja and Strelkova, 1938, cf. Darlington and Wylie, 1955) which, in the light of the present discovery of a taxon with n=7 could be considered as a 7-ploid on the probable base number 7.

Anaphalis nepalensis Spreng.

A dwarf softly woolly perennial found in temperate and alpine Himalayas. Heads 2 to 7 in terminal corymbs, involucral bracts acute, spreading in flower.

Flowers: July-August.

Fig. 35 shows 14 bivalents at diakinesis. One bivalent was associated with the nucleolus. At A₁ 14:14 distribution was observed. Meiosis was regular and 97% of pollen were fertile. The species has been cytologically reported for the first time.

A. triplinervis Clarke

A robust perennial with stout stem. Leaves are stem
clasping and 3-5 nerved, heads numerous forming corymbs. The species is common in the temperate Himalayas.

Flowers: July-August.

This is another taxon with n=14. The present finding confirms the previous report by Mehra et al (1965). Two bivalents were observed to be associated with the nucleolus at diakinesis. Meiosis was regular. Ninety seven percent of pollen were fertile. Chromosomal size is the same as that of the former species.

_A. margaritacea_ (Linn.) Benth. & Hook.f.

A robust leafy herb with densely clothed leaves and much branched corymbs. Flower heads large. Colonies of this plant has an ornamental poise when they are in blossom. It is good for introduction in the group of "everlasting".

Flowers: July-August.

Cytological survey of the populations growing in Simla and Kashmir hills of Western Himalayas and Darjeeling hills of Eastern Himalayas revealed the existence of three intraspecific races (Fig. 36) with n=14, 21, 28. The taxon with n=14 is robust and showed a well branched habit. The branching is absent in the other two taxa. The leaves are long and linear in the taxon with n=21 but relatively shorter and broader in the taxon with n=28 (Fig. 36). The taxon with n=14 was collected from Darjeeling hills. It has been reported by many authors (see Table II).
The race with $n=21$ was recorded from Simla hills and the race with $n=28$ from Kashmir. Both these taxa are new cytotypes. A marked increase in chromosomal and cell size was noted as ploidy increased (Figs. 37, 38, 39). In Fig. 39 the cell wall could not be drawn as it was broken in the process of preparation of the slide. Meiosis was regular in all the three taxa. Ninety eight percent of pollen were fertile in the taxa with $n=14$, 28 and 95% in the third.

*A. adnata* (Wall.) DC.

This is the largest and stoutest of the Indian species of *Anaphalis* with thick stem and obovate-spathulate 3-nerved leaves, heads numerous in dense rounded terminal and axillary corymbs.

Flowers: September-October.

It revealed 14 bivalents at diakinesis which confirms the earlier reports by Shetty (1964) and Mehra *et al* (1965). The species has largest chromosomes among the 12 taxa of *Anaphalis* investigated (Fig. 40). Meiosis was normal and 97% of pollen were viable.

*A. beddomei* Hook.f.

A loose undershrub with decumbent main stem and erect leafy branches. This is a conspicuous species, easily recognised by the elliptic lanceolate 5-ribbed leaves, found in western peninsula. The material was collected from Pulney Hills.
Diakinesis revealed 14 bivalents (Fig. 41). Two of them were associated with the nucleolus. Meiosis was regular and 96% of pollen were fertile. Chromosomes are of medium size. This is a new report.

A. oblonga (Blume) DC.

An exceedingly variable species found in Pulney hills of South India. However, the uniform white cottony clothing and usually short broad leaves with flat margins and indistinct midrib beneath together with small heads, distinguish it at once from the others. Flowers: August-September.

Fourteen bivalents were observable at diakinesis (Fig. 42). Meiosis was regular. The chromosomes are of medium size. Ninety seven percent of pollen were viable. The species has been worked out for the first time.

A. travancorica Sm.

A large herb, somewhat shrubby at the base, with large flower heads, met with in Pulney hills and hills of Kerala. Flowers: July-August.

Fourteen bivalents were discernible at diakinesis. Meiosis was normal and 98% of pollen were stainable. Chromosomes are of medium size. The species has been worked out for the first time.
A. *contorta* (D.Don.) Hook.f.

This is a very variable herb with linear leaves, coloured outer involucral bracts and subglobose heads borne in dense simple lobed corymbose clusters. The species is common in temperate and subalpine Himalayas. Flowers: August-September.

The present report of $n=14$ is in line with the previous report by Mehra et al. (1965). At diakinesis 3 bivalents were found to be associated with the nucleolus. Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size.

A. *wightiana* DC.

An erect herb with woody root stock, white bracts, large heads and numerous flowers, found in cool places and banks of streams. Flowers: July-August.

The species was collected from Nilgiri hills of South India. The finding of $n=14$ (Fig. 44) is a new report. Chromosomes are fairly large. Meiosis was normal and 97% of pollen fertile.

A. *bournei* Fyson.

This is a much branched low bush with long slender flowering branches. The species was collected from Pulney hills of South India. Flowers: July-August.

The present finding of $n=14$ is in line with the report
of Shetty (1964). Three bivalents were associated with a large nucleolus at diakinesis. Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size.

The genus *Anaphalis* is taxonomically separated from its related genera, *Helichrysum* and *Gnaphalium*, by only minor characters such as the colour of the bracts and the fertility of bisexual flowers. In some species (*A. oblonga*) the disk-flowers are all fertile, thus breaking down its generic distinction from *Gnaphalium*.

However, cytologically the genus is homogeneous. Most of the species have 14 pairs of chromosomes. *A. margaritacea* was found to exist in three cytotypes with \( n=14, 21, 28 \) which suggest 7 as the base number for the genus. This is in line with an earlier suggestion of a similar nature by Arano (1965).

*Gnaphalium luteo-album* Linn.

An annual wide-spread conspicuous weed with golden yellow heads, distributed throughout the hills of India. The plant possesses some medicinal properties.

Flowers: April-July.

The present finding of \( n=7 \) from the populations of Simla hills is in line with the previous reports on the species by earlier workers (cf. Table II). However, Larsen (1960) has reported two numbers \( 2n=14, 14+1 \) for the species. Meiosis was regular with 98% pollen fertility. Chromosomes are of medium size.
**G. hypoleucum** DC.

An erect stout "everlasting" annual of temperate Himalayas, which can be easily distinguished by the long acuminate leaves with broadly auricled bases.

**Flowers:** September-October.

Diakinesis revealed 7 bivalents. This confirms the previous report by Arano (1963). Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size.

**G. indicum** Linn.

This is a soft white woolly annual, common along road-sides, waste places and cultivated lands. The species is a common weed during winter months in the fields throughout the plains of India.

**Flowers:** December-April.

A cytological survey of populations of this weed from the foot-hills of Nilgiris revealed a new tetraploid race with n=14 (Fig. 46). The diploid is a more widely distributed taxon which has been reported earlier by Mehra et al (1965) from Darjeeling hills in the Eastern Himalayas and has also been found by the author in the Nilgiris (Fig. 45). However, there were no appreciable morphological differences between the two to distinguish them in the field. Meiosis was regular in both the cases. Diploid showed a pollen fertility of 96% and tetraploid 94%. Chromosomes are of medium size in both.
A common annual of the upper Gangetic plains, introduced from America. It is an erect herb with sparsely cottony stem and minutely papillose achenes. The species closely resembles G. indicum. But it can be readily distinguished by the cohesive nature of its pappus hairs.

Flowers: December-May.

The present finding of $n=7$ (Fig. 47) is the first record of a diploid race of the species. Arano (1963) reported a tetraploid with $2n=28$. Recently Gupta (1969) reported $n=9$ which appears to be erroneous. Meiosis was normal with 98% of pollen fertility. Chromosomes are of medium size.

The genus Gnaphalium consists of diploid, tetraploid and octaploid species on the base number $x=7$. G. luteo-album, G. hypoleucum, G. indicum and G. purpureum, presently studied, are all diploid. The only tetraploid taxon belongs to G. indicum which exists in two intraspecific races. Another diploid, G. uliginosum, was reported by Arano (1965). Earlier he had reported two tetraploids also: G. japonicum and G. purpureum (Arano, 1961). An octaploid with $2n=56$ has been reported by Wulff, Love and Love (cf. Darlington and Wylie, 1955), in the north American species G. norericum. All the other species of Gnaphalium studied by different authors show uniformly $x=7$ with polyploidy in certain cases (Love and Love, 1944; Rutland, 1941; Wulff, 1938).
Helichrysum buddleioides DC.

This is a shrub reaching 4 meters in height with beautiful "everlasting" "flowers". The species is an excellent potential ornamental. Often it has been grown in gardens in Nilgiri hills. Normally the involucral bracts are bright yellow in colour. However, individual plants with white involucral bracts were observed in many localities. The colour variation appears to be genetic since the chromosome number in both types was found to be 2n=28.

Flowers: June-September.

Meiosis was found to undergo a highly disturbed course. At diakinesis quadrivalents and hexavalents were observed (Figs. 48, 49). Non-synchronous disjunction was noticed at A₁. In some cases some bivalents remained as laggards and telophase nuclei of unequal size and of unbalanced constitution were formed (Fig. 50). Often telophase I nuclei appeared highly pycnotic showing signs of degeneration and stickiness. However, some telophase nuclei proceeded further with the nuclear cycle and produced pollen grains of unequal size and shape. Pollen stainability amounted to only 35%. Chromosomes are fairly large in size. The species has been investigated for the first time and it is a tetraploid on the basic number 7.

Helipterum roseum Benth.

This is a native of S. Western Australia, cultivated
in Indian gardens as "everlasting". The plant bears solitary terminal rose coloured heads.

Flowers: February-March.

The present count is the first report of a tetraploid race of the species. Diakinesis revealed 14 bivalents of which one was associated with the nucleolus. However, occasionally one quadrivalent was noticed (Fig. 52). $A_I$ was normal with 14:14 distribution. Ninety five percent of pollen were fertile. Chromosomes are of medium size. Bilquer (1951) reported $2n=14$ for this species.

*Ammobium alatum* R.Br.

This annual, known as "winged everlasting", is grown as an ornamental in winter.

Flowers: February-April.

Thirteen bivalents were discernible at diakinesis (Fig. 53). Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size. Present report is in line with the report by Avanzi (1948).

*Inula racemosa* Hook.

A tall, stout herb with grooved stem and many large heads found in open spots in Juniper tracts of temperate Himalayas. The plant is of considerable medicinal importance. The roots are used as expectorant and as resolvent in indurations, and in veterinary medicine as tonic and stomachic (Chopra et al., 1956).

Flowers: June-July.
The present report of n=10 is in line with the previous reports by Tongiorgi (1942) and Zhukova (1964). Meiosis was regular with 95% of fertile pollen. Chromosomes are of medium size.

I. royleana DC.

A stout herb, with membranous leaves and handsome heads on erect hirsute peduncle. The root is, from its similarity to that of *Saussurea lappa*, used to adulterate that article. The species is common in open hill-sides and mountain paths of temperate Himalayas.

Flowers: July-September.

The present report of n=10 confirms the previous report by Zhukova (1964). Meiosis was found to undergo a slightly disturbed course. However, bivalent formation was complete at diakinesis (Fig. 34). Two bivalents were associated with nucleolus. Bridges (Fig. 35) and laggards were observed at A⁻. Ninety percent of pollen were fertile. Chromosomes are large in size.

I. cappa (Ham.) DC.

An aromatic shrub with stout branches and numerous heads in crowded corymbas, found in sub-Himalayan tracts and outer Himalayas.

Flowers: August-October.

This species is a tetraploid with n=20. Mehra *et al* (1965) reported two intraspecific races belonging to
it, a diploid and a tetraploid. Meiosis was normal and 95% of pollen were fertile. Chromosomes are of medium size.

* * *

I. *eupatoriiodes* DC.

This shrubby plant resembles *I. cuspidata* closely, but can be distinguished by its stouter habit, short petioles and stouter leaves with much reticulated nervation beneath.

Flowers: August-October.

The present report of n=10 is in line with the earlier report by Mehra et al. (1965). Meiosis was normal and 99% of pollen were fertile. Chromosomes are of medium size.

* * *

I. *cuspidata* Clarke

An erect shrub, with heads on slender peduncles, crowded in broad terminal corymb. It is common on steep rocky or precipitous grounds.

Flowers: August-October.

The only previous report on the species is of Mehra et al. (1965). Meiosis was found to undergo a disturbed course. Chromosome breakage, non-homologous associations (Figs. 56-58), stickiness and late disjunction (Fig. 59) were observed in about 65% of cells. However, in some cells at A_1 10:10 separation was noted. About 40% of pollen were stainable. Chromosomes are of medium size.

x=5 and 9 have been reported in American species of *Inula* (Beaman et al., 1962). The Japanese species have
x=8 (Arano, 1965). Arano (1965) has pointed out that the Japanese species have probably been derived from taxa with x=9 through an aneuploid reduction. The Indian taxa have the basic set of 10. *I. cappa* is a polyploid with n=20, whereas the rest of the species have 10 pairs of chromosomes and they are considered as diploid by the writer. Probably 10 is a secondary basic number derived from 5, and from this were derived taxa with 9 and 8 by aneuploid reduction.

**Vicca indica** (Willd.) DC.

An erect herb with bright yellow flowers, and variable leaves. This is distributed throughout the drier parts of India, ascending in the Western Himalayas to 1,200 m. It is common in the undergrowth of deciduous forests and on dry soils.

Flowers: October-March.

The present report of n=9 is in line with the previous report by Mehra et al (1965) who described it from northern India under the name *V. auriculata* Cass. Recently Gupta (1969) reported two cytotypes with n=9 and 2n=27 with meiotic breakdown in the triploid. Meiosis was regular in the presently investigated taxon and 95% of pollen were fertile. Chromosomes are of medium size.

**V. vestita** Benth.

A stout and short plant with numerous narrow ligules, distributed in the drier parts of India. It is common in waste places, usually becoming gregarious.
Flowers: February-May.

Meiosis was regular and 97% of pollen were viable. Chromosomes are large in size.

Pulicaria vulgaris Gaertn.

A dichotomously branched annual with divaricate peduncles, woolly involucral bracts and minute achenes, found commonly in exposed waste lands.

Flowers: June-August.

Diakinesis revealed 9 bivalents (Fig. 61). Two of them were associated with the nucleolus. Though meiosis was normal in most of the cells, occasionally aberrant mother cells were noticed. Laggards and late separation (Fig. 62) were occasional at A_I. Ninety five percent of pollen were fertile. The species has been reported earlier by Wulff (1937) who also found n=9. Chromosomes are of medium size.

Crepesium cernum Linn.

One of the commonest and most variable species with shortly petioled leaves and drooping heads. Outer involucral bracts are leafy. Hooker (1882) described 7 distinct varieties of this species. It is common in woods. This herb is used in medicine in China. Roots contain inulin.

Flowers: August-October.

At diakinesis multivalents consisting of varying
number of chromosomes were noticed in different cells (Fig. 63). Late disjunction was observed at A. pollen fertility was significantly low. Only 55% of the pollen were healthy. The chromosome number was determined from root-tip mitosis which showed clearly \(2n=40\) (Fig. 64). This is in line with the reports by Arano (1962) and Mehra et al (1965). Chromosomes are of medium size.

A perusal of the literature reveals that the species belonging to the genus Carpesium have the basic chromosome number \(x=10\), and rarely 9 which may have been derived from 10 by an aneuploid reduction. Tetraploidy on the basic number 10 has been well established in most of the species. Arano's work has clearly demonstrated that the speciation in this genus has been mainly by the structural changes in chromosomes rather than through the aberrations in chromosome numbers (Arano, 1962, 1965).

Tribe HELIANTHEAE

Acanthospermum hispidum DC.

This an introduction from South America. The plant has spread rapidly and now is a noxious weed in South India. It is common in exposed places, waste lands and fields.

Flowers: June-September.

The present report of mei confirms the earlier report by Miege (1960). Meiosis was regular and 98% of pollen fertile. Chromosomes are of medium size.
Xanthium strumarium Linn.

A highly variable annual plant with scabrid triangular-cordate irregularly toothed leaves and large two-celled fruits with strong hooks. It is common on waste grounds, road sides and rubbish heaps. It prefers open habitats and succumbs to crowding. The seeds are most often dispersed by water and wind. The plant is of medicinal importance.

Flowers: September-June.

The species has been cytologically investigated by many workers (cf. Table II) and the present report of n=18 is in line with these. Populations of this highly variable plant have been studied from many localities in Northern India as well as Southern India but with same result. The extreme forms of this species did not show any difference with regard to chromosome number. Meiosis was regular in all cases and 99% of pollen were fertile. Chromosomes are of medium size.

The species is enormously variable and readily subdivided into a number of minor taxonomic entities. In a biosystematic study Love and Dansereau (1959) concluded that the generalized short-day flowering response in the genus Xanthium supports their hypothesis that it has a tropical sub-tropical origin. They pointed out that an intense inbreeding with an occasional outbreeding is responsible for the enormous variation, often resulting in small, local, but unstable taxa.
Zinnia elegans Jacq.

This is an annual, commonly cultivated for its showy flowers. The bright coloured rays are long enduring. The disk flowers are nearly wholly lacking. This is the parental species from which most of the garden zinnias have been derived.

Flowers: August-October.

At $M_1$ 12 bivalents were discernible (Fig. 65).

This is in line with the reports by Ishikawa (1916), Turner et al (1962) and Torres (1963). Meiosis was regular and 96% of pollen were fertile.

Z. angustifolia H.B.K.

This is a Mexican species which has run wild in many localities in the Simla hills and is likely to spread. It differs from Z. elegans in smaller stature, oblong to ovate-lanceolate sessile leaves and orange heads.

Flowers: August-September.

The present report of $n=12$ is in line with the previous reports by Turner et al (1962) and Torres (1963). Turner et al (1961) and Powell and Turner (1963) also reported $n=11$ for the species. Thus the species exists in two intraspecific races. Meiosis was regular and 96% of pollen were fertile. Chromosomes are of medium size.

Siegesbeckia orientalis Linn.

A cosmopolitan annual met with throughout India with
yellow flowers and large ovate-triangular deeply cut leaves. The flower-heads are glandular and very sticky. It is found in waste places, by road-sides and in second growth forests. The plant is of some medicinal value.

Flowers: November-December.

Populations from Mussoorie and Simla hills of Western Himalayas and Nilgiri and Pulney hills of South India were studied. All of them were diploid with n=15. Diers (1961), Koul (1964) and Turner and Flyr (1966) reported the same number. Mehra et al (1965) reported the existence of two intraspecific races of the species from Mussoorie hills, a diploid with n=15 and a tetraploid with n=30. A difference in distributional pattern was observed by them, tetraploids being found at higher elevation. They studied the differentiating characters of the two taxa. Meiosis was regular in the present material and 97% of pollen were fertile. Chromosomes are of medium size.

Eclipta prostrata (Linn.) Linn.

An annual herb with lanceolate-oblong strigose leaves. "Flowers"are small with white rays. It is common in waste places, road-sides, rice fields and marshy grounds. There are two forms of this species, one erect and the other prostrate. However, they do not otherwise differ in morphological characters. This herb is extensively used in the indigenous medicine.
The species has been worked by many authors and the present report of n=11 is in line with them (cf. Table II). Though meiosis was found to undergo a regular course, a tendency for non-homologous association was noticed in many cells at diakinesis (Fig. 66). A-I was regular and 11:11 separation was observed. Ninety six percent of pollen were viable. Chromosomes are of medium size.

Jatindra Mohan et al. (1962) reported difference in chromosome number between the varieties *E. prostrata* var. *alba* (2n=22) and *E. prostrata* var. *erecta* (2n=18). However, recently, Tandon and Shalla (1967) made some cytological studies of the intraspecific morphological variants of the species. Their studies did not reveal any relationship between morphological diversity and chromosome number. According to Arano (1966) the genus *Eclipta* has only one species, *E. prostrata*, which has emigrated laterally from the warmer subtropical regions and has no karyological affinity with the other genera placed near to it in the tribe Heliantheae.

*Sclerocarpus africanus* Jacq.

An erect annual herb with ovate, Strigosely hairy leaves, yellow flowers, beaked and ribbed achenes. It is a weed in corn fields. This tropical herb ascends up to 1,800 m in Western Himalayas.

*Flowers: Throughhout the year.*

*Flowers: July-August.*
Present report of $n=11$ confirms the previous report by Mehra et al. (1965). Meiosis was regular and 98% of pollen were fertile. Chromosomes are small in size.

**Blainvillea lastifolia** (Linn.f.) DC.

A rigid scabrous herb with yellowish or white flowers and ovate 3-nerved leaves. The achenes are marked with faint horizontal lines. The species is common in corn fields and waste places. It is met with throughout India and ascends up to 1,500 m in the Himalayas. The fresh roots possess a faintly aromatic odour.

**Flowers:** August-October.

The material was collected from Kerala in South India. The present report of $n=17$ (Fig. 67) is a new count for the species. Mehra et al. (1965) reported $n=39$ for the species from Darjeeling hills in the Eastern Himalayas. Thus, the species exists in two intraspecific races. At diakinesis two nucleolei were observed to which one bivalent each was associated. $A_1$ showed 17:17 distribution and meiosis was normal. Ninety seven percent of pollen were fertile. Chromosomes are of medium size.

**Wedelia chinensis** (Osbeck.) Merr.

A procumbent perennial with the stems rooting at nodes, found in wet places and as a submerged plant in ponds. It is not common. It is a valuable medicinal herb.

**Flowers:** February-May.
At diakinesis 25 bivalents were discernible (Fig. 68). Ghosh (1960) and Koul (1964) reported n=25, 2n=50 for the species under the name *W. calendulacea* Less. Meiosis was normal and 95% of pollen fertile. Chromosomes are of medium size.

*W. biflora* (Linn.) DC.

A rambling shrub with ovate, distantly serrate leaves, recurved involucral bracts and shortly cuneate achenes, found on the sea-coast.

Flowers: November-December.

The present report of n=15 confirms the previous report by Chuang *et al.* (1963). Meiosis was regular and 94% of pollen were fertile. Chromosomes are of medium size.

*W. affinis* DC.

A native of the warmer regions of the world, commonly cultivated in gardens as an ornamental. It is particularly suitable for growing in the green houses. The species is very popular in South Indian gardens.

Flowers: September-November.

Fig. 69 shows the gametic number 12 at $M_{II}$. The species has not been cytologically reported earlier. Meiosis was normal and 98% of pollen were fertile. Chromosomes are of medium size.

*Medelia* is a relatively large pantropical genus of about 70 species. Eight haploid numbers, 11, 12, 15,
20, 22, 23, 25 and ca 30 are now established on the basis of Turner's (1964) work. Turner and Irwin (1960) predicted a basic number of $x=10$. The considerable aneuploidy existing led Turner (1964) to think that the ancestral taxa had a high base number and the taxa with lower numbers evolved through chromosomal deletions. The three species reported in the present work have three different gametic numbers, 12, 15 and 25. However, the author feels that the available data in the literature on the genus is not enough to give a clear picture and the genus is in much need of a critical cytological exploration.

**Tithonia diversifolia** A. Gray.

This is a Mexican plant cultivated in hills as an ornamental. Heads are handsome, borne on long fistulose peduncles which are enlarged above. The involucral bracts are rounded.

**Flowers**: August-September.

The present report of $n=17$ is in line with the earlier report by Turner et al. (1961). Meiosis was regular and 92% of pollen were fertile. Chromosomes are large in size.

**I. tagetiflora** Desf.

This is also a native of Mexico. It is a tall soft wooded shrub, bearing alternate leaves and numerous orange-coloured heads resembling small sunflowers. The shrub grows rapidly either from seeds or cuttings and spreads with great rapidity.
Flowers: June-August.

Diakinesis revealed 17 bivalents. This is in line with the report by Bilquez (1951). Meiosis was regular with 96% of pollen fertile. Chromosomes are large in size.

*Helianthus annuus* Linn.

This is the common sunflower, a native of the Western United States of America, grown for economic and ornamental purposes. Several horticultural forms are now under cultivation in India which differ in size of heads, colour of rays and in the extent of multiplication of rays in the so-called double heads. Seeds are used in medicine.

Flowers: April-June.

The chromosome pairing in majority of cells was normal at diakinesis (Fig. 71) and 17 bivalents were formed. But occasionally a few univalents were noticed at diakinesis and M₁. A₁ was abnormal. Different types of irregularities such as lagging of chromosomes, delayed separation of bivalents (Fig. 73), sticky chromosomes etc. were observed in many cells, at late A₁, the widely scattered anaphase chromosomes did not converge to the two poles and failed to be included in the telophase nuclei. Instead a number of nuclei of different size were formed (Fig. 72). However, 60% of pollen were stainable.

The garden sunflower has been the subject of intensive cytogenetic studies. Kostoff (1939) discovered that the hybrid of hexaploid perennial (*H. tuberosus*, 2n=102) and
diploid annual (*H. annuus*, 2n=34) often formed 34 bivalents at meiosis. He concluded that the chromosomes of *H. annuus* were homologous with one genome of *H. tuberosus* and that the remaining 17 bivalents resulted from autosyndesis of two sets of *H. tuberosus* chromosomes. This autoallopolyplploid interpretation of *H. tuberosus* has been accepted by many later workers. However, Darlington (1956) considers it to be an autoployploid of *H. annuus*.

On the results of hybridization experiments Heiser (1965) divided the genus *Helianthus* into four sections representing four different phylogenetic lines.

Hybrids of *H. annuus* with the perennials *H. lactiflorus*, *H. maximiliani*, *H. rigidus* and *H. scaberimus* have been reported by Georgieva-Todorova (1960, 1962, 1963).

**Spilanthes acmella** Linn.

An erect annual herb with ovate leaves. The ligulate flowers are frequently absent. It is a common weed in plains and ascends up to 1,000 m. The plant is considered as a powerful mosquito larvicide. Crushed plant is used as fish poison. Hooker recorded four distinct varieties of this species from India. A large form (var. *oleracea*) is cultivated in gardens. Flowers: October-November.

Malik and Ahmad (1963) reported n=7 for this species. Mehra *et al* (1965) studied the populations in Darjeeling hills of Western Himalayas and reported n=12. The present material from Kerala of South India introduces yet another gametic
number for the species. At diakinesis 26 bivalents were clearly discernible (Fig. 74). Meiosis was regular and 96% of pollen were fertile. Chromosomes are of medium size.

Darlington and Wylie (1955) listed only one species *S. decumbens* which had the 2n number 26. Turner et al (1961) reported n=13 for *S. americana*. Later Turner and King (1964) reported n=26 for the same species. Available data on the genus suggests 13 as the basic number. Thus the present taxon is a tetraploid.

*Synedrella nodiflora* (Linn.) Gaertn.

An erect dichotomous herb with ovate-lanceolate 3-nerved leaves. The achenes are of two very distinct forms, the outer ones winged and spinous, the inner slender and muricate. This is an introduced plant from Mexico. It is now a common weed on cultivated lands.

Flowers: April-July.

Gajapathy (1962) reported n=19 for the species. However, the present report records n=20 at diakinesis (Fig. 75). Meiosis was normal with 99% of pollen fertility. Chromosomes are of medium size.

*Coreopsis grandiflora* Hogg.

This is an attractive perennial cultivated in gardens for showy flowers. Leaves narrow and entire, mostly 3-5 parted, heads large on long stalks, achenes with broad wings. The species is native of Mexico.

Flowers: February-April.
At diakinesis 10 bivalents were discernible. Figs. 76-77 demonstrate the chiasmata distribution at diakinesis. Rings and rods were formed with terminalised and interstitial chiasmata. Meiosis was regular and 93% of pollen fertility was recorded. Chromosomes are large in size.

Gelin (1934) recorded 2n=26 and Turner and Lewis (1965) recorded n=14 for the species. The present report of n=10 is a new count. Hence the species exists in many cytotypes. The basic numbers given by Darlington and Wylie (1955) for the genus Coreopsis are 12, 13 and 14. At least one species, C. nuecensis, is known with the gametic number 9 (Turner, 1960). Recently Gupta (1969) reported n=10 for C. coronata. Consequently the genus is now known to be multibasic with x=9, 10, 12, 13 and 14.

Dahlia coccinea Cav.

A tuberous rooted ornamental cultivated for its beautiful "flowers". The only characters that certainly distinguish this species from D. rosea are its glaucous stem and infertile rays. But these characters break down in the garden form. It is an octaploid (2n=64) on the basic number 8. This race has been reported earlier by Turner et al (1961). Lawrence (1929) reported a tetraploid race of the species. Meiosis was found to undergo a disturbed course. Multivalents and fragments were noticed at diakinesis and M₁. Belated disjunction and laggards were common at A₁. Even at late A₁ after the chromosomes moved to the two poles.
chains consisting of a number of chromosomes were common (Fig. 78). However, 65% of pollen were stainable. The mother cells were remarkably large in size. Chromosomes are of medium size.

**D. excelsa** Benth.

This is known as "Tree Dahlia". Several unbranched stems arise from the base and are marked with horizontal rings. It is found as an escape in Darjeeling and Nilgiri hills.

Flowers: August-September.

The species is a tetraploid with n=16 (Fig. 79). It has been worked out for the first time. Meiosis was normal and 95% of pollen were fertile. Chromosomes are of medium size.

**Cosmos bipinnatus** Cav.

A glabrous annual with white, pink or crimson daisy like "flowers" from Mexico, grown as an ornamental in gardens.

Flowers: April-May.

The present report of n=12 is in line with the previous reports by Sugura (1936), Crowe (1954), Mehra *et al* (1965), and Melchert (1966). However, Powell and Turner (1963) reported n=11. Meiosis was regular and 96% of pollen were fertile. Chromosomes are of medium size.

**C. sulphureus** Cav.

Another Mexican species cultivated in gardens as
ornamental and is often found to have run wild. Heads are large with pink "flowers" and long achenes.

Flowers: April-May.

The material collected from Kodaikanal in South India clearly revealed 13 bivalents at diakinesis (Fig. 80). Meiosis was highly abnormal. Non-homologous associations, sticky chromosomes (Fig. 81), late disjunction, laggards (Fig. 82) and inversion bridges with fragments (Fig. 83) were common. Pollen fertility was significantly low. Only 45% of pollen were healthy. Chromosomes are fairly large. This is a new cytotype. Sugiura (1936) reported 2n=24 for the species. Mehra et al (1965), Turner and Flyr (1966) and Melchert (1968) confirmed this number.

*Cosmos* is a multibasic genus with x=11, 12 and 17 (Turner and Flyr, 1966). Meiotic breakdown in the present material with n=13 may be due to the presence of an extra pair of chromosomes. As pointed out earlier 12 is the common gametic number in this species (Sugiura, 1936, Mehra et al. 1965; Turner and Flyr, 1966; Melchert, 1968).

Recently Melchert (1968) demonstrated an interesting evolutionary dichotomy among the perennial species of *Cosmos*. The rhizome bearing species become suffrutescent and have a basic number of x=11, while the species with fascicled, tuberous roots and strictly herbaceous habit all have a basic number of x=12. He has demonstrated several independently derived polyploid complexes within each of these series.
Bidens biternata (Lour.) Merr. & Sherff.

An erect herb with variable leaves. Heads are with white rays and yellow disk. The barbed achenes are black and slender. It is troublesome when fruiting since the ripe, awned achenes adhere to clothes. The plant has some medicinal properties.

Flowers: March-November.

At diakinesis 36 bivalents were discernible (Fig. 34). This is in line with the earlier reports by Gelin (1934), Covas and Schnack (1946) and Mehra et al. (1965). It is a hexaploid on the basic number 12. Meiosis was regular and 97% of pollen were viable. Chromosomes are of medium size.

B. humilis H.B.K.

This is a pretty yellow flowered species which has run wild along the road sides in the Nilgiris in South India. Flowers: August-September.

It is a diploid on the base number 12. Fig. 35 shows 12 chromosomes at $M_{II}$. Meiosis was regular and 99% of pollen fertile. Chromosomes are of medium size. This species has been reported for the first time.

Bidens is multibasic like its closely related genus Cosmos. The basic numbers involved are 10, 11, 12, 14 and 17 (Turner and Flyr, 1966). The two presently investigated species are based on $x=12$.

Galinsoga parviflora Cav.

A highly variable glabrous herb bearing very small
flower-heads and ovate 3-nerved membranous leaves. It was introduced from America and is now a troublesome weed in cultivated lands and waste places in the Himalayas. Flowers: May-July.

The present report of $n=8$ is in line with the previous reports by many authors (cf. Table II). Meiosis was regular and 98% of pollen were fertile. Chromosomes are of medium size.

Turner and King (1964) reported a tetraploid taxon from Central America and a closely related species *G. urticaefolia* with the same number $n=16$. They think that much of the variations found in *G. parviflora* is due to hybridization with *G. urticaefolia*. Both the species occur in close proximity in some localities of Central America. *G. parviflora* is now widely distributed as a weed throughout much of the temperate world.

**Tridax procumbens** Linn.

A straggling hispid perennial herb with much cut leaves and yellow "flowers". Achenes are with feathery pappus. It was introduced from S. America. It is very common in dry places, road sides and waste lands throughout the plains of India. Flowers: December-May.

It is a tetraploid on the base number 9. Meiosis was found to undergo a mildly disturbed course. However, bivalent formation was complete at diakinesis in the majority
of cells. Eighteen bivalents were discernible at this stage (Fig. 86). Frequently, bridges were formed due to late separation of some bivalents (Fig. 87). Inversion bridges associated with fragments, micronuclei and cytomixis were reported in the species by Mehra et al. (1965). Sixty five percent of pollen were stainable. The species has been reported by many earlier workers with the same number (cf. Table II). Chromosomes are large in size. Recently Tandon and Shalla (1967) made cytological studies on the intra-specific morphological variants of the species. Their studies did not reveal any difference in chromosome number between the variants.

Powell (1965) has observed that Tridax and Galinsoga are very closely related. Galinsoga has a basic chromosome number of \(x=8\). Tridax is diabasic with \(x=9, 10\) (Powell, 1965). Turner and Flyr (1966) believe that Galinsoga and related genera have had a reticulate cytophyletic history, species with \(x=4\) and 5 giving rise to taxa with \(x=8, 9\) and 10 (4+4; 4+5; 5+5). Species with \(n=5\) have not been recorded. However, they observed that the more primitive taxa of Tridax, section Imbricata, with multi-seriate involucres and conical receptacles (Powell, 1965) have gametic number \(n=10\), perhaps reflecting an ancestral base of \(x=5\).

Tribe HELENIIDAE

Tagetes minuta

An erect herb bearing finely divided leaves. Peduncles short, slender, ligules yellowish, suborbicular, achenes
elongated. This is an American species occasionally cultivated in gardens. The plant has been noted on an extensive area in Simla hills and it is likely to spread. Flowers: September-October.

It is a tetraploid on the base number 12. Fig. 83 shows 24 bivalents at diakinesis. Occasionally quadrivalents were noticed at diakinesis and $M_i$. $A_i$ was regular with 24:24 distribution. Ninety five percent of pollen were stainable. Chromosomes are small in size. The species has been investigated for the first time.

**Helenium hoopessii** Gray

A stout perennial, with tomentose stem, bearing one to several long pedunculate heads. It is a fine border plant especially valuable for cut flowers. In India it is cultivated in gardens at hill stations. Flowers: July-August.

Meiotic studies revealed a mildly disturbed course. At diakinesis the pairing was normal. Fifteen bivalents were noticed at $M_i$ (Fig. 89). $A_i$ was irregular in some cells. Belated separation was common (Figs. 90, 91). However, 15:15 distribution (Fig. 92) was noticed at late $A_i$ in majority of cells and further stages were normal. A high percentage of pollen (92%) were fertile. Chromosomes are moderately large in size.

The same number has been reported by many authors (cf. Table II). However, Zhukova (1964) reported $2n=34$ for
the species. For different species of *Helenium* Raven and Kyhos (1961) reported the gametic numbers 13, 14, 15, 16, 17 and 29.

**Tribe ANTHEMIDEAE**

**Achillea millefolium** Linn.

An alpine perennial which bears 3-pinnatisect leaves and heads in corymb. It has stoloniferous subterranean parts. The species is common in alpine pastures of the Himalayas. This perennial is easy to culture and is occasionally cultivated as an ornamental in hills.

**Flowers:** August-October.

Cytological survey of populations growing in Kashmir and Simla hills in the Western Himalayas and Darjeeling hills in the Eastern Himalayas revealed the occurrence of three intraspecific cytotypes (Fig. 93). Diploids were collected from Kashmir, tetraploids from Simla hills and hexaploid from Darjeeling hills. Extensive populations studied have revealed that the cytotypes are localised in these three distantly located areas.

**Diploid**

This taxon grows from 2,200 m to 3,500 m. The plants in the snow ranges are extremely dwarf. At diakinesis seven bivalents were in the form of rings and two had one chiasma each. One of the latter was associated with the nucleolus. Meiosis was normal and 98% of pollen fertile.

**Tetraploid**

This cytotype was found in localities situated at
2,200 m to 3,000 m. Eighteen bivalents were observed at diakinesis. Quadrivalents were noticed occasionally. A1 was normal and 18:18 distribution was observed (Fig. 95). This taxon also had a high percentage of pollen fertility (97%).

Hexaploid

This taxon was not so common as the former two. It was found only in a few localities situated at 2,000 to 2,300 m. In most of the cells 27 bivalents were clearly discernible (Fig. 96). However, occasionally multivalent association was noticed at diakinesis. Further course of meiosis was normal resulting in the formation of 92% of healthy pollen.

*Achillea millefolium* is a widely worked out species. Ehrendorfer ( ) demonstrated how the *A. millefolium* complex merges at polyploid levels with other complexes through the formation of allopolyploids. Between *A. millefolium* and *A. distans*, both of which are hexaploids, there has occurred extensive hybridization (Ehrendorfer, ) with subsequent formation of a very polymorphic hybrid swarm designated as *A. stricta*. Ehrendorfer synthesized many wild hybrid forms by experimental crossing. Hence, the specific status of the three hexaploids, *A. millefolium*, *A. stricta* and *A. distans* is problematic according to his data and they may have to be merged into a single species.

Recently Tyrl (1969) found on a cytogeographical survey of *A. millefolium* that the distributional pattern of the two cytotypes is very complex involving overlapping of ranges. He discovered a naturally occurring pentaploid
hybrid with meiotic pairing of $18_{II}$'s and $9_{I}$'s which could not be distinguished morphologically from the presumed parents.

Tyrl (1969) made a very interesting observation in the tetraploid race. He noticed the presence of unreduced and viable pollen grains ($n=36$) among the normal grains ($n=18$). Should the resultant unreduced gametes be functional, they could contribute to the formation of higher polyploid type. Thus, a hexaploid zygote ($2n=34$) can originate within a tetraploid population by the fertilization of a diploid egg ($n=18$) by a tetraploid pollen grain ($n=36$). This line of thinking led Tyrl to suggest that the North American hexaploid originated by autopolyplody from earlier existing tetraploids (Tyrl, 1969).

**A. sibirica** Ledeb.

This is an erect rigid perennial cultivated in gardens as an ornamental. The "flowers" are large in compact corymbs. Flowers: July-September.

It is a diploid as earlier reported by Mehra et al (1965). Diakinesis revealed 9 bivalents. Two of them were associated with the nucleolus. Meiosis was regular and 97% of pollen were fertile. Chromosomes are of medium size.

**Anthemis cotula** Linn.

An erect annual, bearing gland-dotted leaves which are finely dissected and neuter white ray florets. It is a common ill-scented weed along road-side. The herb is acrid
and blisters the skin.

Flowers: June-July.

At diakinesis 9 bivalents were discernible. This is in line with the previous reports by Harling (1950) and Mulligon (1957). Meiosis was normal and 96% of pollen fertile. Chromosomes are fairly large in size.

**A. fuscata** Brot.

An erect annual with dissected leaves and white conspicuous ray florets. Involucre, cup-shaped, scales membranaceous at the margin, receptacle convex. The plant was found as an escape in Pahalgam, Kashmir.

Flowers: June-July.

At diakinesis 16 bivalents were clearly discernible (Fig. 97). Meiosis was regular. At A_1 16:16 distribution was noticed. Ninety seven percent of pollen were fertile. Chromosomes are moderately large. The species has been reported for the first time.

Most of the species of *Anthemis* have chromosome numbers based on 9 (Darlington and Wylie, 1955; Cave, 1955-65). However, Larsen (1954) reported 2n=16 for *A. maritima* (Cave, 1959).

**Chrysanthemum leucanthemum** Linn.

It is a weedy perennial bearing terminal heads with strikingly white ray florets. Large colonies when in flower are most beautiful to look at and decorate the landscape. The species is an excellent potential ornamental.
It was not recorded by Hooker (1832). Probably it is a recent introduction. It grows commonly at Kashmir and Simla hills in the Western Himalayas and Darjeeling in the Eastern Himalayas.

Flowers: July-August.

The species exists in two intraspecific races (Fig. 98).

Diploid

This taxon is not very common. It was collected from Simla hills. Diakinesis revealed 9 bivalents which were of the ring and rod type. $A_I$ was regular and 9:9 distribution was observed (Fig. 99). 93% of pollen were fertile. Chromosomes are fairly large in size.

Tetraploid

Tetraploid populations were studied from several localities in Kashmir and Simla hills in the Western Himalayas. At diakinesis quadrivalents were common (Fig. 101). It was difficult to get well spread metaphase plates due to stickiness of chromosomes and non-homologous associations. However, some cells were obtained which revealed 18 bivalents at diakinesis (Fig. 100). Occasionally laggards were noticed at $A_I$ which organized themselves into a micronucleus (Fig. 102). However, 80% of pollen were healthy.

Extensive cytogeographical survey has revealed that the tetraploid is more abundant and widespread in the Himalayas than the diploid. The latter is restricted in distribution. However, in North America the diploid is
reported to be more common and the tetraploid is localized (Mulligen, 1950). According to this author taxa with somatic numbers 18, 36 and 54 occur in Europe.

C. carinatum Schousboe.

This is the commonest and gaudiest of the annual Chrysanthemums, distinguished by the keeled or ridged scales of involucre and the dark purple disk. It belongs to Morocco and is cultivated in India as a winter annual. Flowers: March-April.

It is a diploid with n=9. Meiotic studies revealed the formation of a single interchange heterozygote at diakinesis. In the majority of cells 4 ring bivalents, each with two terminalised chiasmata, and three rod bivalents with a single chiasma in each, and a ring of four chromosomes were observed (Fig. 103). This confirms the report by Jain and Gupta (1960). Meiosis was regular and further course of meiosis was normal. Ninety percent of pollen were fertile. Chromosomes are large in size.

C. coronarium Linn.

A native of Mediterranean region, cultivated in gardens as a winter annual. The double forms with reflexed and imbricated rays are popular. The "flowers" are used as a substitute for chamomile. Flowers: March-April.

It is another diploid which shows heterozygotic
associations (Fig. 104). However, in 25% of mother cells mostly 9 ring shaped bivalents were detected (Fig. 105). A_1 was regular with 9:9 distribution (Fig. 106). Ninety percent of pollen were stainable. The species also has large chromosomes. Shimotomai (1935) has reported 2n=18, 36 for the species.

**C. segetum** Linn.

A sparsely foliaged annual with stem-clasping leaves which are variable. The lower leaves are petioled. The involucral bracts are broad and the rays are of golden yellow colour. The species is cultivated in gardens as an ornamental. But in India it is not as popular as *C. carinatum* and *C. coronarium*. In Darjeeling and Nilgiri hills the plant was found as an escape in many waste places.

Flowers: June-August.

It is another diploid (n=9) annual in which the structural heterozygosity was noticed. Fig. 107 shows one ring of 4 chromosomes, and 7 bivalents of which 6 are rings with two terminalised chiasmata and one, a rod bivalent. Further course of meiosis was normal and 92% of pollen fertility was recorded. Chromosomes are large in size. Dowrick (1952) reported two intraspecific races of this species with 2n=18, 36.

**C. corymbosum** Linn.

A stout perennial bearing 2-pinnatisect leaves. Heads are small in flat-topped cluster. The species belong to the
Mediterranean region and is occasionally cultivated in gardens as an ornamental.

Flowers: July-August.

Nine bivalents were discernible at diakinesis. At A<sub>i</sub> 9:9 separation was noticed and 98% of pollen were fertile. Chromosomes are not as large as those of the former species.

*C. arisanense* Hayata

=(*C. indicum* sensu Hayata)

This is a perennial, native of China and Japan, grown in gardens for cut flowers. Heads are many in small clusters, on short peduncles. It is supposed to be one of the parental species from which by endless variation and hybridization, the highly developed glasshouse Chrysanthemums have come (Bailey, 1947). This species has some medicinal properties.

Flowers: November-December.

At diakinesis 9 bivalents were discernible (Fig. 108). Seven were rings and two were rods, one of which was associated with the nucleolus. A<sub>i</sub> was regular, and no significant aberrations were observed. Ninety five percent of pollen were fertile. Chromosomes are fairly large in size. Tetraploids and hexaploids are known in this species (Dowrick, 1952; Tanaka, 1955).

Occurrence of a single interchange heterozygote in annual Chrysanthemums:

A single interchange heterozygote was observed in three species of annual Chrysanthemums, *C. carinatum.*
This was observed in the perennial species \textit{C. leucanthemum} also but only in the tetraploid taxon. The diploid perennial species \textit{C. corymbosum}, \textit{C. arisanense} and the diploid race of \textit{C. leucanthemum} did not show any such phenomenon.

Rana and Jain (1964) reported the occurrence of interchange heterozygote in three populations of \textit{C. carinatum} which had three different origins. Although the exact nature of the advantage associated with the chromosomal heterozygosity remains to be determined, Rana and Jain (1964) have pointed out that the heterozygous combination may result in a superior genetic balance.

\textit{Tanacetum longifolium} Wall.

A very distinct species in leaves which are very long and finely cut. Heads are in the form of a close woolly corymb, occasionally reduced to one when it is large in size. The roots of this perennial species are woody and crowned with the shining base of the old petioles. Flowers are bright yellow. The species is restricted to alpine meadows of temperate Himalayas.

Flowers: July-August.

At diakinesis 9 ring and rod bivalents were discernible (Fig. 109). \( A_i \) showed 9:9 separation (Fig. 110). Further course of meiosis was regular and 92\% of pollen were fertile. Chromosomes are large in size. The species has been reported for the first time.
Artemisia parviflora Buch.-Ham.

A faintly scented perennial herb with highly variable leaves. Heads are sessile or on short capillary stalks. Achenes are minute. The species is distributed in Himalayas and hilly places throughout India.

Flowers: August-September.

Khoshoo and Sobti (1958) reported a diploid taxon of the species from the Himalayas. The present study revealed the existence of a tetraploid race in many localities of Pulney hills in S. India. This cytotype has been reported for the first time. Various interesting cytological situations were observed during meiosis. Secondary associations were common at diakinesis and M1 but the type of association varied from cell to cell. In some cells 1-3 rings of 4 chromosomes were noticed (Fig. 111, 112). In many others chains of 4 chromosomes (Fig. 113) were observed. Most of the chromosomes were involved in quadrivalent association and the taxon is probably an autotetraploid. Bivalents were mostly of the rod type. However, 2-3 ring bivalents were noticed in some cells. At A1 multivalents showed late separation. Further course of meiosis was normal and pollen fertility amounted to 85%.

A. scoparia Waldst. & Kit.

An erect well branched perennial herb bearing leaves which are finely cut into filiform segments. Heads are minute and heterogamous. The species is common as a weed in the fields of rainy season crops. It is eaten by the
cattle. The plant is of some medicinal importance. Seeds and flowering heads contain essential oil. Flowers: September-October.

It is a diploid with n=9. Fig. 114 displays chiasma distribution in the bivalents at diakinesis. Four bivalents were typical rods, 4 were rings and 1 had a single interstitial chiasma. Three rings were associated with the nucleolus. Meiosis was regular and 94% of pollen fertile. The previous reports are by Khoshoo and Sobti (1958) n=8, 2n=16 and Kawatani and Ohno (1964) 2n=16, 36. Thus this is a new diploid cytotype, probably the original parental taxon which has given rise to taxa with 2n=16 (Khoshoo and Sobti, 1958) and 2n=36 (Kawatani and Ohno, 1964) by aneuploidy and polyploidy respectively.

*A. vulgaris* Linn.

A tall aromatic shrub reaching 5-6 ft. high, often gregarious. The leaves vary from lobulate to 2-3 pinnatisect and from green or hoary on both surfaces to thickly clothed tomentose beneath. The plant is emmenagogue, anthelmintic, antiseptic and stomachic. It contains essential oil (Chopra et al, 1956). Flowers: July-August.

The species has been extensively studied by various authors. Diploids, tetraploids, hexaploids and taxa with accessory chromosomes are known (cf. Table II). A new cytotype, a pentaploid, has now been discovered from S. India.
On an extensive survey of populations growing in Nilgiri and Pulney hills and hills of Kerala, it has been found that the species is represented by two taxa, diploid and pentaploid (Fig. 113). Diploid is common and pentaploid is very rare and has been collected only from a few localities.

Diploid

Fig. 116 demonstrates the chiasmata distribution at diakinesis. In majority of cells 5 ring bivalents and 4 rod bivalents were observed. However, in some cells 6 rings were noticed. Two bivalents (or probably three) were associated with a well differentiated nucleolus. Meiosis was regular and 96% of pollen fertile. Chromosomes are large in size.

Pentaploid

A marked reduction in chromosome size was noticed in this taxon. Various types of aberrations resulted in total meiotic breakdown. Apart from the fact that this is probably a hybrid, between hexaploid and tetraploid, the taxon had an unbalanced chromosome number of 2n=45. In majority of cells various associations and clumping of chromosomes were noticed at diakinesis and M₁. However, some cells could be located in which bivalent formation was noticeable (Fig. 117). The congression of the chromosomes on the spindle at M₁ was completely imperfect. In some cells the chromosomes were oriented on apparently 2 or more equatorial plates. A₁ was highly abnormal. An active polar movement was lacking. Variable number of
laggards and bridges were common. However, in some cells it was possible to count the chromosomes at late A₁ (Fig. 118, 23:22). Univalents were found to lag behind on the spindle. Various abnormal cells were noticed with masses of clumped chromatin material and micronuclei (Figs. 119, 120). At telophase II pentads were common (Fig. 121). Daughter cells and their nuclei were of different size, evidently due to the different chromosomal constitution.

Even in the tetraploid, which in all probability is one of the parents of the present taxon, meiosis was found to undergo a highly disturbed course (Koul, 1964). The hexaploid is already known (Khoshoo and Sobti, 1958; Zhukova, 1964). Therefore, the present taxon in all probability is a hybrid between the two.

A. vulgaris has been cytologically explored by many workers (cf. Table II). Numerous taxa varying in phenotype have been shown to exist in N. America by Keck (1946), in N.W. Himalayas of India by Mukerjee (1932), Khoshoo and Sobti (1958) and Koul (1964). Diploid, tetraploid and hexaploid have been reported by the latter workers from the Himalayas.

In an intensive meiotic study of the tetraploid race Koul (1964) has observed numerous aberrations like poor spindle development, absence of bivalent formation, common occurrence of tri-and tetra-valents, nonorientation of univalents, micronuclei etc. He has concluded that autopolyploidy has contributed to meiotic instability. Phenomena
like non-disjunction and complement fractionation of chromosomes have been found to add to meiotic aberrations.

Meiotic variability and consequent instability in the pentaploid is evidently due to its unbalanced genomic constitution coupled with a high degree of homology between more than two sets of chromosomes.

On the basis of gene ecological observations Koul (1964) questioned the validity of species complex *A. vulgare* and broke it into two subspecies:

I. *A. vulgare indica* (Indian), originating from a basic number of 9 and exhibiting intraspecific polyploidy coupled with morphological variations and ecological isolation. If this has to be held the presently investigated cytotype comes under this sub-species.

II. *A. vulgare orientalis* (European), originating from a basic number of 8 and does not show any cytological races and seems to be evolutionary stagnant.

Koul (1964) has brought to light morphological, ecological and cytogenetical differences existing between these two subspecies and argued that the differences are so sharp that it becomes imperative to separate these two into definite subspecies.

*A. nilagirica* (Clarke) Pamp.

A gregarious, strong scented perennial about 2 m high growing in dense clumps. Leaves alternate and 2-3 pinnatisect. This species is distributed throughout the
hills of India and is often mistaken for *A. vulgaris*.
Flowers: October-January.

It is a diploid on the base number 9. Meiosis was regular and at A₁ 9:9 separation was observed (Fig. 122). Ninety eight percent of pollen were stainable. Chromosomes are large in size. The species has been cytologically reported for the first time.

*A. roxburghiana* Besser

This species can at once be distinguished by its creeping rootstock, herbaceous habit and finely cut leaves. The heads vary in form from hemispheric to ovoid. It is common in alpine hills of Kashmir ascending to 3,500 m. Flowers: August-September.

The present report of n=9 is in line with the earlier report by Suzuki (1952-53), Khoshoo and Sooti (1958) and Koul (1964). Diploids and tetraploids are known in this species (cf. Table II). The present material was diploid. Meiosis was regular and 95% of pollen fertile. Chromosomes are large in size like those in the other diploid species of *Artemisia*.

*A. sacrorum* var. *vestita* (DC.)

= (*A. vestita* Wall.)

A shrubby perennial bearing finely divided leaves which are twice pinnate. Heads, hemispheric and long stalked, achenes ellipsoid and shining. The species is common in Simla hills. It yields essential oil. Flowers: September-October.
The present report of n=9 is consistent with the previous report by Suzuka (1952-53), Khoshoo and Sobti (1958), Koul (1964) and Mehra et al (1969). Kawatani and Ohno (1964) reported a tetraploid race with 2n=36.

At diakinesis non-homologous associations were occasionally observed. Fig. 123 shows 4 bivalents, one quadrivalent and a hexavalent. However, in 60% of cells 9 bivalents were noticed at diakinesis. Fig. 124 shows delayed separation of a bivalent. Ninety four percent of pollen were fertile. Chromosomes are moderately large in size.

*A. absinthium* Linn.

...n aromatic silky hoary perennial with angular and ribbed stem and 2-3 pinnatifidly cut leaves. Heads pedicelled and hemispheric. The species is common in Kashmir. This is the source of Absinthin and an essential oil.

Flowers: July-August.

It is a diploid which showed 9 bivalents in majority of cells at diakinesis. However, occasionally quadrivalents were noticed (Figs. 125, 126). A detailed analysis of diakinesis revealed that the distribution of chiasmata varied from cell to cell (Figs. 127-130). Two bivalents were associated with the nucleolus. A1 was regular with equal distribution of chromosomes. Ninety four percent of pollen fertility was recorded. Chromosomes are large in size. The present report is in agreement with the previous report by
Khoshoo and Sobti (1958) and Koul (1964).

**Chrysanthemum** and **Artemisia**

In *Artemisia* it was shown by Arano (1965) that with the increase in the number of chromosomes there is decrease in their size. Generally the diploid species have relatively large chromosomes and a nearly symmetrical karyotype. The basic chromosome numbers in this genus are 9 and 8, and according to this author 17 and 26 are derived from the diploid number of 18 and triploid number of 27 respectively by the loss of one pair of chromosomes in each case.

Arano also found strong karyological similarities between the diploid species of *Artemisia* and *Chrysanthemum*. Such similarities indicate that they have a close phylogenetic relationship and perhaps a common origin. However, in *Artemisia* speciation is based not only on the polyploidization but also on the aneuploid reduction, whereas in *Chrysanthemum* diversification of species have been carried out primarily through polyploidy.

**Tribe SENECIONEAE**

**Doronicum roylei** DC.

A perennial with corymbose, branched stem, and yellow "flowers" on long slender stalks. Achenes oblong, deeply grooved. It is common in damp wooded hill-sides. The plant is used in Indian medicine as an aromatic tonic (Bamber, C.J., 1916).

Flowers: June-July.
At diakinesis 30 bivalents were observable (Fig. 131). Meiosis was regular and 95% of pollen fertile. Chromosomes were of medium size. The genus *Doronicum* is said to have a high base number of \( x=30 \) (Darlington and Wylie, 1955). Zhukova (1964) reported a number of species with \( 2n=60 \). However, Ornduff et al (1963) considers 10 as the base number in this genus.

**Gynura nepalensis** DC.

A tall handsome succulent herb, stem corymbosely branched, leaves hairy-pubescent on both surfaces, heads many, corymbose, often large and broad. Flowers: June-July.

M_1 revealed 10 bivalents (Fig. 132). The species has been reported earlier by Mehra et al (1965) and the present finding confirms this report. Meiosis was regular and 97% of pollen were fertile. Chromosomes are large in size.

**G. cusimbua** Moore.

=*G. angulosa* DC.

A robust corymbosely branched herb with many large heads. Peduncles, involucral bracts and achenes are all glabrous. It is distributed throughout the hills of India. Flowers: August-October.

This species has been investigated by Mehra et al (1965) under *G. angulosa* DC. They reported two races, a diploid which is usually unbranched and generally distributed
at higher elevations and a tetraploid which is relatively large in size, branched or unbranched and met with at lower altitudes. The populations investigated by the present writer from Pulney, Nilgiri and Kerala hills from S. India are all tetraploid.

Mehra et al. (1965) reported a normal course of meiosis in diploid and tetraploid. However, in the present tetraploid material 30% of cells exhibited quadrivalents at diakinesis. Usually 2 rings of 4 were observed (Fig. 134). In the rest of the cells 20 bivalents were noticed (Fig. 133). The taxon is probably an autotetraploid. Further course of meiosis was normal and 90% of pollen fertility was recorded.

Emilia sonchifolia (Linn.) DC.

A very variable herb which grows in a wide range of altitude from 1,000 to 3,000 m. Some populations are erect and others have a diffuse habit. Flowers are purple and the achenes 5-ribbed and scabrid. It is commonly found on slopes and one rocks.

Flowers: July-September.

All the populations from different localities of Nilgiri and Pulney hills in South India were diploid with n=5. Two of the bivalents were attached to the nucleolus. Morphological variations found even in the extreme forms were not associated with any difference in chromosome number. Meiosis was regular and 95% of pollen were fertile. Chromosomes are moderately large in size.
The present report is in line with the reports by Baldwin (1946), Turner and King (1964) and Mehra et al. (1965). Arano (1962) reported a tetraploid with $n=10$, $2n=20$.

*Emilia javanica* (Burm.f.) Merr.

An annual with long stem terminated by clusters of small scarlet heads. It is a native of tropical Africa and is cultivated in gardens.

Flowers: February-April.

Also a diploid. Five bivalents were observed at diakinesis (Fig. 136) of which two were associated with the nucleolus. Meiosis was normal and 98% of pollen fertile. The chromosomes are about the same size as in the previous species.

This report is in line with the reports by Afzelius (1924) and Baldwin and Speese (1948).

*Notonia grandiflora* DC.

A small fleshy shrub with stout branches, rare in Pulney hills. The species has been collected from rocky slopes.

Flowers: August-September.

Diakinesis revealed 10 bivalents (Fig. 137). One of these was associated with the nucleolus. Further course of meiosis was regular and 96% of pollen were stainable. Chromosomes are large in size.

This report is in line with the previous reports by Ganesan (1939) and Koul (1964).
**Senecio graciliflorus DC.**

It is a gaulbrous plant bearing large petioled pinnatifid leaves and a number bractellate heads. The species is common in the forests of temperate Himalayas. Flowers: August-September.

Mehra et al (1963) reported the chromosome number from root-tip mitosis as 2n=40. The present finding from the PMCs confirms this report. During diakinesis and MI a certain amount of stickiness was noticed which made spreading difficult. However, some cells could be obtained which revealed 20 bivalents clearly. Most of them were ring shaped (Fig. 138). Further course of meiosis was normal and 85% of pollen fertile. Chromosomes are moderately large in size.

**S. chrysanthemoides DC.**

This is the commonest Senecio of the Himalayas. It is a robust herb with highly variable leaves. Hooker (1882) described five distinct taxa. A remarkable reduction in size of the plant was noticed with increase in altitude. Thus in Kashmir hills, the populations at Tangmarg (2,000 m) were 2 m high, those in Gulmarg (2,700 m) 1 m high and those at Khillenmarg (3,300 m) only 0.3 m high. A cytological survey of these, however, revealed the same chromosome number. All were with n=20 which confirms the previous report by Mehra et al (1965). Multivalents consisting of varying number of chromosomes were noticed at diakinesis and MI in 25% of cells (Fig. 139). However,
further stages of meiosis were regular and 90% of pollen were fertile. Chromosomes are of medium size.

S. nudicaulis Buch.-Ham.

Scapigerous habit, obovate leaves and the 3-nerved involucral bracts distinguish this species from all the others in the genus. It is common on dry slopes of temperate Himalayas.

Flowers: May-June.

It is another polyploid. A marked reduction in chromosome size was noticed in comparison with S. gracili-florus. In 20% of cells non-homologous associations were noticed, but in the rest 20 bivalents were clearly discernible (Fig. 140). Further course of meiosis was regular and 90% of pollen were fertile.

S. coronopifolius Desf.

A slender annual with divaricating branches and scattered leaves. The species has been collected from Simla hills, where it is found occasionally on slopes and walls. However, Collet (1921) did not record the species from the area.

Flowers: August-September.

It is also a polyploid showing 20 bivalents at diakinesis (Fig. 141). No meiotic irregularities were observed. Ninety-five percent of pollen were fertile. Chromosomes are of medium size. The species has been cytologically reported for the first time.
S. scandans Don.
A climbing plant with zig-zag branches and numerous leaves. The auricles of petioles are highly variable. The heads are in lax divaricate rounded corymbs. The species has been studied from Darjeeling in the Eastern Himalayas and hills of Kerala in the South.
Flowers: June-August.

It is a tetraploid on the base number 5 with n=10. This record is in line with the earlier reports (cf. Table II). Meiosis was regular and 95% of pollen were fertile. Chromosomes are of medium size. However, they are larger in comparison with the species S. coronopifolius and S. nudicaulis.

S. alatus Wall.
Flowers: August-September.

It is also a polyploid, but shows a striking increase in chromosome size compared to the tetraploid S. scandans and S. rufinervis. At diakinesis 10 ring bivalents, with terminalised chiasmata, two bivalents, each with two interstitial chiasmata and 8 bivalents, each with a single chiasma were observed. Meiosis was normal and 92% of pollen were viable. The present report of chromosome number confirms the report by Mehra et al (1965).
**S. rufinervis** DC.

A shrubby plant, corymbs clothed with appressed cottony wool, heads many, bracteolate, achenes glabrous. The species is common in forests.

Flowers: August-September.

An octaploid taxon with n=20 has been reported by Mehra *et al.* (1965) from Darjeeling and Simla hills. A new cytotype, probably an aneuploid derived from the normal octaploid, has now been discovered. At diakinesis 16 bivalents were clearly discernible (Fig. 142). Three bivalents were associated with the nucleolus. Meiosis was regular and 92% of pollen fertile. Chromosomes are large in size.

**S. elegans** Linn.

This is a South African annual cultivated in gardens as an ornamental. The common form of the species has double flowers.

Flowers: February-April.

It is a tetraploid and the present report of n=10 is consistent with the previous reports (cf. Table II). The chromosomes were significantly smaller compared to *S. rufinervis* and *S. alatus*. Meiosis was regular and 95% of pollen stainable.

**S. cuentus** DC.

A short stemmed perennial, native of Canary islands, cultivated in green houses for its beautiful flowers. Whether the present highly improved races of the species are direct
Ketotic studies revealed that the taxon is a 12-ploid on x=5. Fig. 143 shows 30 bivalents at diakinesis, which is in line with the earlier reports by Larsen (1958, 1960). One bivalent was associated with the nucleolus. This species has the smallest chromosomes among the species of Senecio investigated presently. Meiosis was regular and 93% of pollen fertility was recorded.

Among the 9 species of Senecio investigated, 2 are tetraploid, 6 octaploid and 1 12-ploid on the base number 5. S. ruflinervis (n=18) is probably an aneuploid derived from an octaploid taxon with n=20 by the loss of two pairs of chromosomes. The octaploid with n=20 has been recorded earlier from the Himalayas (Mehra et al, 1965).

Most of the authors have considered 5 as the base number for Senecio or Senecioneae (Afzelius, 1940; Darlington and Wylie, 1955; Beaman et al, 1962). Turner and Lewis (1965) reported three species with n=5 (S. abyssinicus, S. discifolius, and S. hockii). S. arenarius is known to possess 9 pairs of chromosomes. According to Afzelius (1949) this species belongs to the flora of the Cape Province and is often cultivated in gardens. It resembles S. elegans which has 10 pairs of chromosomes and also originates from Cape Province. Stepwise chromosome reduction is certainly one of the means in the speciation of this genus.
Some workers, including Arano (1962) have postulated an ancestral base number of \( x=10 \) for Senecio and Senecioneae. They argue that if \( x=5 \) represents the base number, chromosome numbers in multiples of 5 and not of 10 would be expected. Such numbers have \( n=15, 25, 35 \) etc. are rare or absent. Taxa with \( n=5 \) are found in only 5 or 6 species which are all annuals. Annual habit is frequent in taxa at the lower end of reduction series. Ornduf et al. (1963) likewise are of the opinion that the base number for Senecio and the tribe Senecioneae is 10, the higher numbers be regarded as polyploid or aneuploid derivatives and lower numbers as having been derived by stepwise reduction.

Arano (1962) has shown that the genus Senecio has preserved a primitive karyotype. A regular polyploid series was obtained from diploid to octaploid and in addition, aneuploid series was derived. He considers the genus as a phylogenetically primitive taxon of ancient origin.

Tribe CALENDOLEAE

*Dimorphotheca aurantiaca* DC.

This is one of the best ornamentals of recent years. The "flowers" open in the sun making a brilliant display in summer season. The present cultivated strain is a half hardy annual.

Flowers: February-April.

The species is a diploid with \( n=9 \) which in line with the previous reports by Harrison (1937) and Mehra et al.
(1965). Meiosis was regular and 93% of pollen were fertile. Chromosomes are of medium size.

_Calendula officinalis_ Linn.

A very popular annual species cultivated in gardens as an ornamental. The lower leaves are spatulate and upper lanceolate, achenes curved and boat-shaped.

Flowers: March-May.

Negodi (1936) reported 2n=28 for this species. The present finding of n=16 is in line with the report by Meddle (1941), Janaki Ammal (1962) and Mehra _et al_ (1965). Meiosis was found to undergo a regular course with 95% of fertile pollen. Chromosomes are of medium size.

Tribe ARCTOTIDAE

_Gazania rigens_ R. Br.

A showy perennial grown in gardens as an ornamental. The stem has ascending branches, heads large and showy with orange rays and purplish disk florets.

Flowers: August-September.

The present report of n=7 is not in line with the previous findings of _La Cour_ (1945) who reported 2n=10. Fig. 144 shows 7 chromosomes at each pole. Meiosis was regular and 95% of pollen fertile. Chromosomes are of medium size.

_G. krebsiana_ Less.

This species is also cultivated in gardens as an ornamental. The plant has showy heads and it is quite
popular, especially in South India where it is cultivated in hill stations.

Flowers: August-September.

This species has been cytologically reported for the first time. Fig. 145 illustrates chiasmata formation at diakinesis in 7 bivalents. Five were rings, one had two interstitial chiasmata and one was a typical rod bivalent. One of the rings was associated with the nucleolus. Meiosis was regular and 95% of pollen were fertile.

Tribe CYNAREAE

Echinops cornigerus DC.

The erect habit and large heads distinguish it at once from E. echinatus to which it closely resembles. The outer involucral bracts are surrounded by bristles.

Flowers: August-September.

The present finding of n=14 confirms the previous report by Mehra et al (1965). Meiosis was regular and 98% of pollen fertile. Chromosomes are large.

E. niveus Wall.

The numerous narrow, much divided leaves, which are often recurved distinguish it from E. cornigerus. The species is common in Simla hills, especially in the outer ranges. It is usually found at lower altitude between 1,000 m to 2,000 m, whereas the former species is abundant at altitudes between 2,000 and 3,000 meters.

Flowers: August-September.
M_1_ revealed 14 bivalents (Fig. 146). This report is not in line with the previous report by Mehra et al. (1965) who recorded n=11 for the species. A_1_ was regular with 14:14 distribution. Meiosis was normal and 93% of pollen fertile. Chromosomes are large.

There is considerable variation in regard to chromosome number in the different species of Echinoops so far cytologically investigated. Somatic chromosome numbers of 28, 30 and 32 have been reported for some species of the genus by Moore and Frankton (1962). The two species investigated in the present work have the gametic number 14. However, Mehra et al. (1965) reported n=11 for E. niveus. The available information thus is not sufficient to determine the original base number. The genus and more species need to be investigated.

Arctium lappa Linn.

A tall coarse herb with stoutly peduncled heads and rigid slender involucral bracts. Corolla and stamens are purple. The plants have some medicinal properties. Roots contain inulin.

Flowers: September-October.

The present finding of n=18 is in line with the previous report by Nakajima (1936) and Mehra et al. (1965). However, Sugiura (1936) reported 2n=32. At diakinesis two bivalents were associated with the nucleolus. Meiosis was normal and 95% of pollen fertile. Chromosomes are large in size.
Cousinia microcarpa Boiss.

A slender species characterised by runcinate radical leaves, winged stems and absence of pappus.

Flowers: July-September.

Koul (1964) reported n=13, 2n=26 for the species. However, the present report of n=10 reveals that the species exists in two cytotypes. At diakinesis 10 bivalents were clearly discernible (Fig. 147). Meiosis was regular and 95% of pollen were fertile. Chromosomes are of medium size.

Carduus nutans Linn.

A highly variable stout biennial thistle with winged spinous stem. Leaves 1-2 pinnatifid and spinous. Heads drooping. Hooker (1882) records that the Indian specimens show all transitions between large stout plants with solitary heads to slender ones with fascicled or solitary or subracemose or panicled heads. The plant is common in temperate and sub-alpine Himalayas. In a taxonomic study of Carduus, Mulligan and Frankton (1954) presented a key for the identification of C. nutans, C. crispus and C. acanthoides.

Flowers: June-September.

The present finding of n=20 confirms the previous report by Mehra et al (1965). This is a pentaploid on the base number 8. The diploid taxon of this species has been reported by many authors (cf. Table II). Meiosis was found to undergo a mildly disturbed course with laggards and bridges at AI. However, 85% of pollen were stainable. Chromosomes are of medium size.
The two basic numbers 8 and 11 have long been known in *Carduus*. The somatic number 18 reported by Larsen (1954) for *C. persoonata* from Switzerland introduced the number 9. Natural hybrids between *C. nutans* and *C. acanthoides* with all chromosome numbers between those of the parents are known (Moore and Mulligan, 1956). Eleven is the highest base number known in the genus, and this number, being the least reduced, is considered to be the most primitive. Hence Moore and Frankton (1962) concluded that a base number higher than 11 is not to be expected in *Carduus*.

*Cnicus arvensis* Hoffm.

A perennial species with creeping roots and shortly peduncled heads. Achenes are smooth and shining. This is common in waste land and other exposed places in plains. Flowers: April-May.

The present finding of *n=17* is in line with the previous report by Mehra et al. (1965). Seventeen bivalents were discernible at diakinesis and *M*₁ (Fig. 148). Further meiotic stages were regular and 94% of pollen were fertile. Chromosomes are of medium size.

*C. argyraeanthus* DC.

A slender species bearing strongly spinescent leaves which are glabrous above and glabrate beneath. Heads are sessile and densely fascicled. The involucral bracts have woolly margins. The species is common in the Himalayas in the inner ranges.
Flowers: July-September.

Meiotic studies confirm the previous report by Mehra et al (1965). At diakinesis 17 bivalents were discernible. Ninety eight percent of pollen were fertile. Chromosomes are of medium size. However, they are smaller than those of the former species.

*C. wallichii* DC.

An extremely variable plant with spreading branches and sinuate-pinnatifid leaves. Heads are solitary on naked peduncles, or sessile, fascicled and involucrate. Hooker described 6 distinct varieties which pass into one another in a most perplexing fashion (Hooker, 1882).

Flowers: July-October.

It is also a diploid, diakinesis clearly revealing 17 bivalents (Fig. 149). Four bivalents were associated with the nucleolus. Meiosis was regular and 95% pollen fertile. Chromosomes are of medium size.

*Saussurea candicans* Clarke

A robust plant bearing divided leaves and large heads. The achenes are 5-angled and muricate. The species is found in sub-tropical and temperate regions.

Flowers: April-June.

Cytological survey in the Western Himalayas revealed that the species exists in two intraspecific races, one with n=16 and the other with n=17. The taxon with n=16 is the common cytotype which has been reported earlier by Mehra et al.
Figs. 150 and 151 illustrate diakinesis in these taxa. Three bivalents were associated with the nucleolus in both the cytotypes. Though both showed a regular course of meiosis, occasionally bridges (Fig. 152) and laggards were noticed in the taxon with n=17. However, pollen fertility was high in the two taxa being of the order of 95%. Chromosomes are moderately large in size.

Most species of the genus *Saussurea* are diploid with the basic number x=13 (Arano, 1964). According to this author, species of the genus *Saussurea* originated from South Western Asia (Arano, 1965).

**Tricholepis stewartei** Clarke

A very distinct species with rigid branches, sessile leaves and shortly peduncled heads.

Flowers: July-August.

The present finding of n=8 confirms the previous report by Mehra *et al* (1965). Meiosis was normal and 93% pollen fertile. Chromosomes are of medium size.

**T. elongata** DC.

An erect herb with sparingly branched stem and variable leaves which are sessile, linear oblong-lanceolate or elliptic. The involucral bracts have ciliate tips and the achenes are acutely angled. The species is common in the Simla hills.

Flowers: August-September.

The species is a tetraploid with n=16. This finding is in line with the previous report by *Mehra et al* (1965).
Meiosis was regular and 94% of pollen fertile. Chromosomes are of medium size.

Carthamus tinctorius Linn.

The safflower, a very important Asiatic dye plant, is a native of India. But now it is widely distributed in most warm countries. Not only are the flowers used for dye, but the seeds furnish an edible oil which has a wide range of utility, and the leaves are used as salad. The oil is employed for soap, paints, varnishes and as an illuminant. In India over 1,000,000 acres are planted with Safflower. It is extensively cultivated in Egypt and the Orient and to some extent in the United States for its oil. The leaves of the species are unarmed and entire. It is a glabrous plant with terminal heads which are yellow in colour. Flowers: March–June.

The species is diploid. Twelve bivalents were discernible at diakinesis. This report is in line with the earlier reports by Podoubnaja (1931) and Mehra et al (1965). Two nucleolei were noticed at diakinesis to which one bivalent each was associated. Meiosis was regular and 96% of pollen fertile. Chromosomes are of medium size.

C. oxyacantha Bieb.

This is a wild relative of Safflower, an introduced obnoxious weed found amongst summer season crops. It occurs abundantly in fallow fields and waste grounds. Stem and
anches are lower leaves are shortly spinulose-toothed. The upper leaves are very spinous. The heads are orange yellow in colour.

Flowers: May-June.

The present finding of n=12 is in line with the previous reports by Kishore (1951) and Mehra *et al* (1965). Occasionally laggards were observed at A₁. However, 95% pollen were fertile. Chromosomes are of medium size.

*C. lanatus* Linn.

A very rigid plant with erect stem and large heads. The outer involucral bracts are leafy. Flowers are pale yellow and the achenes thick and broad. The species is common in the Kashmir valley.

Flowers: June-August.

This is an octaploid on x=3. Thirty two bivalents were discernible at diakinesis. Five nucleolei were noticed at this stage. The present finding is in line with the previous report by Poddubnaja (1931). Hanlet (1963) studied two subspecies *C. lanatus* ssp. *creticus* and *C. lanatus* ssp. *lanatus* and reported 2n=32 and 2n=22 respectively. Meiosis in the present taxon was regular and 92% pollen fertile. Though a high polyploid, this species had the largest chromosomes among the presently investigated species of *Carthamus*.

Tribe **MUTISIEAE**

*Gerbera lanuginosa* Benth.

A scapiger us perennial with beautiful large cottony
heads and woolly leaves. The achenes are ribbed. It is common on slopes and on rocks. The plant is a good potential horticultural.

Flowers: June-July.

The present finding of n=23 confirms the previous report by Mehra et al. (1965). Meiosis was regular and 96% of pollen fertile. Chromosomes are of medium size.

_A. jamesonii_ Bolus.

A brilliant summer-blooming perennial cultivated in gardens as an ornamental. It has solitary showy orange coloured heads.

Flowers: June-July.

A partially disturbed course of meiosis in a strain of this species with laggards and micronuclei was described by Koul (1964). In the present material such aberrations were not common. At diakinesis 25 bivalents were clearly observable. This report is in line with the previous records (cf. Table II). Ninety seven percent of pollen were fertile. The chromosomes are of medium size.

Tribe CICHORIEAE

_Cichorium intybus_ Linnl

An erect hispid herb with bright blue heads which are sessile and homogamous. The achenes are glabrous. The plant has white latex. It is a native of Europe, but is met in a wild state throughout Kashmir valley and many other regions.
of Western Himalayas. The endive is supposed to be a cultivated form of this species.

Flowers: April-June.

The present report of \( n=9 \) is in line with the previous reports by several authors (cf Table II). Meiosis was regular with 99% fertile pollen. The chromosomes are of medium size.

**Lapsana communis Linn.**

An annual herb bearing membranous leaves and corymbose heads. The involucral bracts are keeled.

Flowers: June-July.

The species has been cytologically investigated by several authors and three intraspecific races are now known. Love and Love (1948) reported \( 2n=12 \), Stebbins et al (1953) \( 2n=14 \) and Sorsa (1962, 1963) \( n=8, 2n=16 \). The present material corresponds to the taxon which Stebbins studied. At diakinesis 7 bivalents were discernible. The number of nucleoli varied from cell to cell even in PMC's squashed from the same bud (Figs. 153-155). Meiosis was regular and 97% pollen fertile. Chromosomes are large in size.

**Picris hieracioides Linn.**

This is an erect coarse herb with rough hispid stem and oblong sessile leaves. The achenes are narrowly beaked and have feathery deciduous pappus. It is common in temperate Himalayas and Nilgiri hills.

Flowers: April-September.

It is a diploid showing 5 bivalents at diakinesis(Fig.156).
This is in line with the reports by Bergman (1932), Perret in Love and Love (1961) and Mehra et al (1965). Meiosis was regular and 96% pollen fertile. The chromosomes are of medium size.

*Youngia japonica* (Linn.) DC.

A very slender annual which has minute yellow flowers. The achenes are reddish brown and pappus silvery. It is common in shady places.

*Flowers*: March-June.

The present report of \( n=3 \) is in concordance with the previous reports by several authors (cf. Table II). Meiosis was normal with 98% fertile pollen. The chromosomes are of medium size.

*Crepis stoliczkai* Clarke

A perennial with corymbose branched flowering stem which is glandular above. The achenes are finely ribbed and with white pappus.

*Flowers*: April-June.

Diskinesis revealed 5 bivalents (Fig. 157). In the majority of cells 3 bivalents showed one chiasma and two had two chiasmata in each. The latter two bivalents were associated with the nucleolus. At \( a_1 \) 5:5 separation was observed. However, occasionally precocious separation of two bivalents was noticed (Fig. 158). Further course of was normal and 97% pollen fertile.
**Pterothea falconeri** Hook.

This is an annual with variable radical leaves. The flowering stems are leafless and subcorymbosely branched above, achenes ribbed, slender and with white pappus. There is some controversy around the taxonomical status of this genus. Though Hooker (1832) kept it separate from *Crepis*, he suggested the merger of the genus in *Crepis*. Babcock (1947) divided the genus *Crepis* into 27 sections, keeping *P. falconeri* as a minor variant of *C. sancta* subspecies *bifida*. Cassini, Lessing, DeCandolle, Flori and Rouy (cf. Babcock, 1947) recognised *Pterothea* Cass as a distinct genus. The presence of receptacular bristles in *P. falconeri* and the chromosomal number 2n=6 for it and 2n=10 for *C. sancta* led Mehra et al. (1965) to challenge Babcock's treatment of the taxon. It would be interesting to see whether *P. falconeri* can be successfully crossed with *C. sancta* and the results of this experiment may shed some light on this taxonomical problem.

Flowers: May-June.

An interesting feature noted was the variation in chiasmata distribution from cell to cell. The second largest bivalent which usually had one sub-terminal chiasma (Fig. 15) was always associated with the nucleolus. This pair was shown to possess a satellite (Mehra et al., 1965). In some cells this bivalent had two chiasmata (Figs. 160, 161). The largest bivalent which usually had two interstitial chiasmata showed only one chiasma in some cells.
Hieracium crocatum Fries.

An erect herb with leafy stem and conspicuous heads which are few in number. The species is found in the sub-alpine hills of Ladakh and Kashmir.

Flowers: June-July.

Meiotic studies revealed it to be a triploid with $2n=27$. At diakinesis and $M_I$ quadrivalents, trivalents and univalents were noticed (Figs. 162-164). In many cells the chromosomes were scattered and not oriented on the metaphase plate (Fig. 164). Non-synchronous irregular distribution of chromosomes were observed at $A_I$ (Fig. 165). Fig. 166 illustrates 27 chromosomes irregularly distributed in the cell at mixed $A_I$. Chromosomal associations were noticed even at $A_{II}$ (Fig. 167). Pollen stainability was 35%. Chromosomes are of medium size.

H. umbellatum Linn.

A perennial scapigerous eglandular herb. Heads yellow, involucral bracts many and achenes ribbed.

Flowers: June-August.

Meliotic studies revealed 9 bivalents at diakinesis which is consistent with the reports by Lovkvist (1962), Hedberg and Hedberg (1964). Sokolovskaya (1963) found a
triploid with 2n=27. Meiosis was regular in the present material and 98% of pollen were fertile. Chromosomes are of medium size.

**Hypochoeris glabra** Linn.

An introduced European species which has run wild in Nilgiri hills. It is a scapigorous annual with many slender flowering stems and rosettes of pinnatifid leaves which are glabrous. The heads are cylindrical. It has achenes of two types. Outer short and truncate and the inner distinctly beaked.

**Flowers:** June-August.

The present report of 2n=10 is in line with the reports by earlier workers (Stebbins et al., 1953; Shetty, 1967). Negodi (1935), however, found 2n=12 for the species. Two pairs of chromosomes of the five had secondary constrictions (Fig. 168). Chromosomes are of medium size.

**H. radicata** Linn.

A perennial herb closely resembling the former. However, its leaves are conspicuously hairy and the achenes are of one type only. The latter are long and beaked.

This species is not included in any of the floras. It was recorded from South India for the first time by Kammathy (1963).

**Flowers:** June-August.

The species differs from the former in chromosome number
also. At diakinesis 4 bivalents were observed. This is in line with the reports by previous workers (cf. Table II). A1 was normal with 4:4 separation of chromosomes. Pollen fertility amounted to 98%. The chromosomes are of medium size.

* Taraxacum officinale * Wigg.

A perennial scapigerous milky herb. The species is most variable and a number of forms have been recognised by various workers. The leaves are all radical and sessile, usually glabrous and highly variable in size and morphology. Achenes are oblong or obovoid or dorsally compressed. They are beaked and ribbed.

Gamble (1921) observed this plant as a rare weed in Nilgiris and Pulneys in South India. But it appears that the plant has spread rapidly and now it is one of the commonest perennials of Nilgiris and Pulneys. Hooker (1832) felt "It is remarkable that this common Himalayan plant should not be found in the Khasia or Nilgiri mountains, even as a garden escape".

The species is now commercially grown for herbage vegetables (Hill, 1952) and used as an adulterant for coffee. The plant is of medicinal value.

Flowers: Throughout the year.

This highly variable herb exists in a number of intraspecific cytotypes (cf. Table II). Takemoto (1956) reported two races with 2n=24, 26. Fumkranz (1960) reported
7 races with \(2n=16, 18, 24, 32, 34, 36, 37\). From the Himalayas three cytotypes were reported by Mehra et al. (1965) with \(2n=24, 27, 32\). The present work has exposed a still new taxon, a pentaploid with \(2n=40\).

**Triploid**

This is the most widely distributed taxon. The size and morphology of leaf were found to be affected by the environment. Plants growing in shady and moist places generally have longer and broader leaves. This taxon has been studied from a number of localities in the Nilgiri and Pulney hills and from Western Himalayas. In all the cases meiosis was highly abnormal. Univalents and multivalents were noticed at diakinesis and \(M_I\). Trivalents were common (Fig. 170). \(A_I\) was highly abnormal. In the meiotic division the number of chromosomes in each group varied. Meiotic irregularities were clearly reflected in the fertility of pollen. The percentage of full and stainable grains was only 25.

**Tetraploid**

This cytotype is comparatively rare. It was collected from the alpine hills of Kashmir. The perennial herb remains under snow for the major part of the year. Plants were very small (Fig. 169). However, this can not be related to its chromosomal constitution. The triploid taxon in the alpine regions also showed remarkable reduction in size and growth. Inspite of being a tetraploid meiotic irregularities were common. However, the number of bivalents
were more than in the previous taxon (Fig. 171). Unexpectedly quadrivalents were not common. Precocious disjunction of chromosomes due to lack of chiasma formation was frequent and as a result many univalents were observed (Fig. 172). The distribution of chromosomes at A_I was unequal. Meiotic aberrations were reflected in pollen fertility. Only 35% of pollen were fertile.

Pentaploid

This taxon is also rare. It was collected from the alpine zones of Simla hills. These plants remain under snow only during the winter months and hence the growth was not much stunted.

Meiotic studies revealed a highly disturbed course. Various secondary associations were noted at diplotene (Fig. 173) and diakinesis. A_I was highly irregular with non-synchronised separation, irregular distribution of chromosomes (Fig. 174), and laggards (Fig. 175). Even at late A_I, some chromosomes were involved in associations (Figs. 174, 175, 176). The second division was also irregular. Related separation and fragments were noted (Fig. 177). The number of chromosomes in each group varied and poly-sporous condition, with spores of unequal sizes resulted. The full and stainable pollen grains amounted to only 30%.

Lactuca scariola Linn.

A tall herb bearing glabrous sessile runcinate-pinnatifid leaves. The heads are few flowered and the
Achenes are many ribbed.
Flowers: March-November.

The chromosomal count of $n=9$ agrees with those reported for the species by Mulligan (1957) and Mehra et al. (1965). Meiosis was regular with 95% of fertile pollen. Chromosomes are of medium size.

L. dissecta D.Don.

An annual with dichotomously branched stem and narrow cylindric few flowered heads. The achenes are 3-ribbed. It is common in the temperate Himalayas.
Flowers: April-September.

The present report of $n=8$ is consistent with the previous reports by Mehra et al. (1965) and Shetty (1967). Meiosis was regular and 97% pollen fertile. Chromosomes are small in size. Among the 6 species of Lactuca studied this species had the smallest chromosomes.

L. longifolia DC.

A tall annual, paniculately branched above, with sessile leaves and heads in panicle. It is found in sub-alpine hills of Kashmir.
Flowers: June-July.

At diakinesis 8 bivalents were discernible (Fig. 178). A$I$ was normal with equal distribution of chromosomes (Fig. 179). The species has been reported for the first time. Ninety eight percent pollen were fertile. Chromosomes are fairly large.
Lactuca rapunculoides (DC.) Cl. Comp. Ind. 268, 1876.

var. mehraiana Rema. Var. nov.

A new taxon of Lactuca rapunculoides (DC.) Cl., which differs from the type species in many characters, has been collected from Gulmarg (2,700 m) in the Kashmir hills. It can be easily distinguished from the type species by the coarsely irregularly toothed leaf-margin, much branched paniculate inflorescences, short, peduncled heads (Fig. 181) which are more or less laxly arranged on the branches, shorter, stouter, more compressed achenes (Fig. 182) with distinctly contracted short beak and shorter pappus. It resembles L. decipiens Cl. (which seems to be a varient of L. hastata DC.) in its vegetative characters and inflorescence, but differs in having shorter, few-flowered, more or less glabrous or thinly hispid heads, 2-seriate involucral bracts with outer ones much shorter than the inner ones, subterete reddish-brown, transeversely striate, glabrous achenes.

It seems that this taxon may yet be another intermediate that connects Prenanthes Linn. with Lactuca Linn. through L. rapunculoides (DC.) Cl. It could be a hybrid between L. rapunculoides and L. decipiens, as the characters of this interesting plant are intermediate between these two species.

Flowers: July-September.

Diakinesis revealed 8 bivalents (Fig. 183) of which one was associated with the nucleolus. $A_1$ was regular with $d:3$ separation. Further meiotic stages were also normal and
94% of pollen stainable. Chromosomes are large in size. The species has been cytologically reported for the first time.

**L. hastata** DC.

A tall robust perennial with bluish-purple flowers met with in the temperate Himalayas. It also occurs in the form of dwarf and slender plants which vary from perfectly glabrous to glandular-hispid all over. The heads contain 10 to 30 flowers and the achenes are distinctly beaked.

Flowers: August-September.

It is also a diploid with n=8. This report is consistent with the previous reports by Stebbins *et al* (1953), Mehra *et al* (1965) and Shetty (1967). Meiosis was regular and 95% pollen fertile. Chromosomes are fairly large.

**L. macrorhiza** Hook.

A perennial with soft ascending stems and branches, which grows commonly on wall and slopes. Leaves are membranous. Achenes flat, elliptic-lanceolate, narrowed into a beak. They bear a silky white pappus.

Flowers: August-September.

This is another diploid with n=8. The species was shown to exist in two cytotypes by Mehra *et al* (1965). They noticed morphological differences between the two races found in localities separated by wide differences in elevation.

The present study was made from populations growing
in Mussorie, Simla and Kashmir hills. At diakinesis 8 bivalents were discernible (Fig. 184). Non-homologous associations were noticed in 40% of cells (Figs. 185-187). At A₁ 8:8 separation was observed in most of the cells. However, occasionally laggards were noticed (Fig. 188). Second meiotic division was regular and 90% of pollen were fertile. Chromosomes are large in size.

**Prenanthes brunoniana** Wall.

An erect herb found in the woods of sub-alpine Himalayas. The morphology of the leaves is so variable that it is difficult to arrange their forms under any system. The heads contain 3 to 5 flowers and the achenes are without beak.

Flowers: August-September.

The finding of n=8 confirms the previous report by Mehra et al. (1965). Meiosis was normal and 93% pollen fertile. Chromosomes are of medium size.

**Picrildium tingitanum** Deaf.

An annual with stout stem and elongate-ovate radical leaves, involucral bracts cordate with broad membranous margin.

Flowers: June-August.

Fig. 189 illustrates chiasmata formation in the large 9 bivalents. A₁ was normal with 9:9 separation. The present finding confirms the previous report by Mehra et al. (1965). Ninety six percent pollen were fertile. Chromosomes are large in size.
Sonchus asper (Linn.) Garsault.

An erect herb bearing half-amplexical leaves and heads in unbellate cymes. The achenes are 3-ribbed. It is common in waste places.

Flowers: February-April.

The species has been studied by many workers and the present report of n=9 is in line with their records. At diakinesis one bivalent was associated with the nucleolus. Meiosis was normal and 97% of pollen fertile. Chromosomes are of medium size.

S. oleraceus Linn.

A fleshy milky annual common on roadsides, gardens and cultivated lands. The leaves are auricled and bracts glabrous. The achenes are ribbed.

Flowers: February-April.

This species also has been worked out by many authors and the present report of n=16 is in line with the previous reports. Four bivalents were associated with the nucleolus at diakinesis. Meiosis was normal with 95% of pollen fertility. Chromosomes are of medium size.

S. arvensis Linn.

A tall perennial with radical leaves, appressed auricles and glandular hispid bracts. The achenes are ribbed and transversely rugose. It is common in waste places and fields. The latex is said to be used in eye troubles.

Flowers: December-March.
It is a diploid exhibiting 9 bivalents at $M_T$ (Fig. 190).

Meiosis was regular and 93% of pollen fertile.

Canadian material of *S. arvensis* was found by Mulligan (1957) to have 54 somatic chromosomes. This number was first reported by Shumovich and Montgomery (1955). Mulligan (1957) also reported $2n=36$ and 45 in different subspecies of *S. arvensis*.

*Launaea nudicaulis* Hook.f.

A perennial scapigerous herb with pinnatifid leaves and heads in cluster. The achenes are polymorphic, inner usually 4-ribbed, outer curved with a thick ventral and several dorsal ribs. It is common throughout the Punjab plains.

**Flowers:** September-March.

It is a diploid and $M_I$ revealed 9 bivalents (Fig. 191). Occasionally irregularities like laggards and belated separation of bivalents were noticed at $A_I$. However, 92% of pollen were fertile. Chromosomes are large in size.

*L. sarmentosa* (Willd.) Sch.-Bip.

A trailing perennial found on sandy sea shores of S. India. The involucral bracts have white membranous margins. The achenes are thickly ribbed. The plant is useful as a soil binder.

**Flowers:** November-December.

The species has been reported by Jatindra Mohan (1962) under the name *L. pinnatifida* Cass. The present finding of $2n=18$ from root-tip mitosis is consistent with this report. Chromosomes are of medium size and possess median and submedian primary constriction (Fig. 192).
One pair has satellites. There is a marked reduction in chromosome size compared to the former species.

**Tragopogon gracile** D. Don.

A glabrous perennial with linear keeled radical leaves. Heads terminal and long-peduncled, ligules yellow, achenes smooth. It is found on grassy slopes in the outer Himalayas. Flowers: May-October.

Cytologically the species is quite interesting. It has n=6 chromosomes. Populations studied from various localities of Kasauli hills of the Western Himalayas revealed the presence of a pair of large chromosomes with distinct blocks of heterochromatic segments. This pair has a deep primary constriction at a submedian position (Fig. 195). The heterochromatic blocks were confined only to the distal segment. This large pair was associated with the nucleolus at diakinesis (Figs. 193-196) along with another bivalent. It is the last to separate at A_I (Figs. 200-201). The large bivalent had two chiasmata and the others usually formed rings. Non-homologous associations were frequent (Figs. 198, 199). However, second division of meiosis was regular and 70% pollen stainable.

**T. pratense** Linn.

A much taller species than the former with branched leafy stem. Involucral bracts often exceed the ligules. Achenes long-beaked and muricate. The species is met with at lower altitudes. It is quite common in Kashmir valley.
Flowers: June-July.

The diploid taxon has been reported by many authors (cf. Table II). A new tetraploid cytotype has now been discovered from Kashmir valley. Diakinesis revealed 12 bivalents (Fig. 203). Meiosis was regular and 97% pollen fertile. Chromosomes are large in size.

\textit{Scorzonera divaricata} Turez.

A perennial with grooved stems which are branched from the base. Leaves slender and curved. Heads cylindric, ligules yellow and the achenes slender. The species is met with occasionally in the alpine hills of Ladakh. Flowers: June-July.

It is a diploid on the base number 7. Figs. 204-208 illustrate chiasmata formation. In majority of cells 5 rings were noted. However, in some cells only 4 rings were observed (Fig. 204). An interesting feature is the interlocking of bivalents. Fig. 204 shows interlocking of 2 or probably 3 bivalents and Fig. 205 clearly illustrates interlocking of 2 bivalents at two places. \( \Lambda I \) was regular in most of the cells with equal distribution of chromosomes (Fig. 209). However, rarely belated separation was noted. The second division was normal and fertile pollen amounted to 95%. The chromosomes are large in size. The species has been investigated for the first time.
<table>
<thead>
<tr>
<th>Taxa</th>
<th>Locality</th>
<th>Chromosome number</th>
<th>Ploidy</th>
<th>Previous reports</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vernonia monosia</em> DC.</td>
<td>Coonoor, 1,950 m. Nilgiris</td>
<td>n=27</td>
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<td><em>V. sinerea</em> <em>(Linn.</em>) Lees.</td>
<td>Veli, 0 m. Kerala</td>
<td>n=9</td>
<td>2x</td>
<td>2n=18: Grant 1953, Mangenot &amp; Mangenot 1957, Miege 1960.</td>
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<td><em>V. novoboracensis</em> Willd.</td>
<td>Darjeeling, 2,100 m. (Cult.)</td>
<td>n=9</td>
<td>2x</td>
<td>n=9: Mehra et al 1965</td>
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<td>EUPATORIEAE</td>
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<tr>
<td><em>Adenostemma leavenia</em> <em>(Linn.</em>) Kuntze.*</td>
<td>Bonacaud, 1,200 m. Kerala</td>
<td>n=10</td>
<td>2x</td>
<td>n=10: Gajapathy 1962, Mehra et al 1965.</td>
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<td></td>
<td>Devikulam, 1,200 m. Kerala</td>
<td>n=10</td>
<td>2x</td>
<td></td>
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<tr>
<td>Species</td>
<td>Location</td>
<td>Elevation</td>
<td>ploidy</td>
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<td>Nilgiris</td>
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<td></td>
<td>Cootacamond, 2,100 m.</td>
<td>n=10</td>
<td>4x</td>
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<td>Nilgiris</td>
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<tr>
<td></td>
<td>Dehradun, 650 m.</td>
<td>n=10</td>
<td>3x</td>
<td>2n=51: Grant 1953, Mehr et al. 1965.</td>
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<td></td>
<td>U.P.</td>
<td>n=20</td>
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<tr>
<td><strong>Eupatorium clandulosum</strong> H.B.K.</td>
<td>Cootacamond, 2,100 m.</td>
<td>2n=51</td>
<td>3x</td>
<td>2n=58: Ghosh 1961.</td>
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<td></td>
<td>Nilgiris</td>
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<td></td>
<td>Moodar, 1,000 m.</td>
<td>2n=51</td>
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<td>Kerala</td>
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<td><strong>Solidago virgaurea</strong> Linn.</td>
<td>Gulmarg, 2,700 m.</td>
<td>n=9</td>
<td>2x</td>
<td>2n=18: Borgmann 1964.</td>
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<tr>
<td></td>
<td>Kashmir</td>
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<tr>
<td></td>
<td>Mussoorie, 2000 m.</td>
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<tr>
<td><strong>Dichrocephala bicolor</strong> (Roth)</td>
<td>Dodabatta, 2,595 m.</td>
<td>n=9</td>
<td>2x</td>
<td>2n=18: Borgmann 1964.</td>
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<td>Nilgiris</td>
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<tr>
<td></td>
<td>Simla, 2,200 m.</td>
<td>n=9</td>
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<tr>
<td>Species</td>
<td>Location</td>
<td>n</td>
<td>Polyploid</td>
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<tr>
<td><em>Gнranee maderasanana</em></td>
<td>Takadi, 1000 m.</td>
<td>9</td>
<td>2x</td>
<td>2n=18: Mitra 1947.</td>
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<td>(Linn.) Poir.</td>
<td>Kerala</td>
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<tr>
<td><em>Myriactis richtii</em> DC.</td>
<td>Dodabetta, 2,595 m.</td>
<td>18</td>
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<td>n=18, 2n=36: Mehra et al 1965.</td>
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<td>Nilgiris</td>
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<tr>
<td><em>M. nepalensis</em> Less.</td>
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<td>18</td>
<td>2x</td>
<td>2n=36: Mehra et al 1965.</td>
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<tr>
<td><em>M. wallchita</em> Less.</td>
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<td>2x</td>
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<tr>
<td><em>Bellis perennis</em> Linn.</td>
<td>Srinagar, 1,500 m.</td>
<td>9</td>
<td>2x</td>
<td>2n=18: Negodi 1935,</td>
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<td></td>
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<td></td>
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<td>Love &amp; Love 1956,</td>
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<td>Gadella &amp; Kliphuis 1963.</td>
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<td>n=9: Turner &amp; King 1964,</td>
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<td>Mehra et al 1965.</td>
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<td><em>Callistephus chinensis</em></td>
<td>Simla, 2,200 m.</td>
<td>9</td>
<td>2x</td>
<td>n=18, 19: Vaarama &amp; Sulkinoja 1958</td>
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<td>Nees.</td>
<td>(Cult.)</td>
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<tr>
<td><em>Aster mollivacululus</em> Wall.</td>
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<td>2x</td>
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<td></td>
<td>(Cult.)</td>
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<tr>
<td><em>A. thomsoni</em> Clarke</td>
<td>Bhag, 2,850 m.</td>
<td>18</td>
<td>4x</td>
<td>2n=27: Annen 1945,</td>
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<td></td>
<td>Simla</td>
<td>36</td>
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<td>n=9: Mehra et al 1965.</td>
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<td><em>A. peduncularis</em> Wall.</td>
<td>Charabra, 2,600 m.</td>
<td>27</td>
<td>6x</td>
<td>Under A. Asperulus Nees</td>
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<td></td>
<td>Simla</td>
<td></td>
<td></td>
<td>2n=54: Huziwara 1965,</td>
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<tr>
<td></td>
<td>Mussoorie, 2000 m.</td>
<td>27</td>
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<tr>
<td><em>A. linariifolius</em> Linn.</td>
<td>Darjeeling, 2,100 m.</td>
<td>9</td>
<td>2x</td>
<td>n=9: Mehra et al 1965.</td>
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<td></td>
<td>(Cult.)</td>
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<tr>
<td><em>A. amellus</em> Linn.</td>
<td>Simla, 2,200 m.</td>
<td>27</td>
<td>6x</td>
<td>2n=18, 66, 76: Annen 1945,</td>
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<td></td>
<td>(Cult.)</td>
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<td>2n=18: Chatterji 1962,</td>
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<tr>
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<td>Population</td>
<td>Chromosome number</td>
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<tr>
<td><em>Brachyactis robusta</em> Benth.</td>
<td>Gulmarg, 2,700 m. Kashmir</td>
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<td><em>E. bonariensis</em> Linn.</td>
<td>Saari, 1,200 m. Simla</td>
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<td>Simla, 2,200 m.</td>
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<td><em>E. andryalooides</em> Benth.</td>
<td>Darasa, 2,500 m. Ladakh</td>
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<td><em>E. alpinus</em> Linn.</td>
<td>Tungmarg</td>
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<td><em>E. multiradiatus</em> Benth.</td>
<td>Gulmarg, 2,700 m. Kashmir</td>
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<td><em>E. mucronatus</em> DC.</td>
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<td><em>Convexa japonica</em> (Thumb.) Less.</td>
<td>Simla, 2,200 m.</td>
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<td><em>G. stricta</em> Willd</td>
<td>Charabra, 2,600 m. Simla</td>
<td>n=9</td>
<td>2x</td>
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<td></td>
<td>Pykara, 2,350 m. Nilgiris</td>
<td>n=9</td>
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**INULEAE**

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<tr>
<th>Species</th>
<th>Location</th>
<th>Population</th>
<th>Chromosome number</th>
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<td><em>Blumea mollis</em> (D.Don) Merr.</td>
<td>Bassanthpur, 750 m. Simla</td>
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<td>Trivandrum, 0 m. Kerala</td>
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<td>n=9: Mehra et al 1965.</td>
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<td>n=11: Turner &amp; Lewis 1965</td>
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<tr>
<td>Species</td>
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<td><em>B. laciniosa</em> (Roxb.) DC.</td>
<td>Basanthpur</td>
<td>750</td>
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<td><em>Langgera alata</em> (D. Don) Sch.-Bip</td>
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<td><em>A. triplinervis</em> Clarke</td>
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<td><em>A. oblonga</em> (Blume) DC.</td>
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<td><em>A. corylifolia</em> (D.Don) Hook. f.</td>
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<td><em>A. michelianae</em> DC.</td>
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<td><em>A. bournei</em> Pyson</td>
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<td><em>Gnaphalium luteo-album</em> Linn.</td>
<td>Narkanda, 2,700 m.</td>
<td>7</td>
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<td><em>G. hypoleucum</em> DC.</td>
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<td><em>G. indicum</em> Linn.</td>
<td>Kotagiri, 1,950 m.</td>
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<tr>
<td>+ <em>G. purpureum</em> Linn.</td>
<td>Coonoor, 1,950 m.</td>
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<tr>
<td>+ <em>Helichrysum huddliaaides</em> DC.</td>
<td>Coonoor, 1,950 m.</td>
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<tr>
<td>+ <em>Helipterum roseum</em> Benth.</td>
<td>Chandigarh, 240 m.</td>
<td>14</td>
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<td><em>Ammobium alatum</em> R.Br.</td>
<td>Chandigarh, 240 m.</td>
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n=14: Mehr et al 1965.
2n=14; Wulff 1937
2n=14, 14+1; Larsen 1960
n=7; Mehra et al 1965,
Shetty 1967.
n=7: Mehra et al 1965.
2n=14; Bilquer 1951, n=7; Rana & Jain 1963
2n=26; Avanzi, 1948.
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<th>Species</th>
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<td><em>Inula racemosa</em> Hook.</td>
<td>Tangmarg, 2,000 m.</td>
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<td>2n=20: Tongiorgi 1942, Zhukova 1964.</td>
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<td><em>I. xerolea</em> DC.</td>
<td>Khillenmarg, 3,300 m.</td>
<td>n=10</td>
<td>2n=20: Zhukova 1964</td>
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<td><em>I. capa</em> (Ham.) DC.</td>
<td>Darjeeling, 2,100 m.</td>
<td>n=20</td>
<td>4x n=10, 20: Mehra et al 1965.</td>
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<td><em>I. cuspidata</em> Clarke</td>
<td>Darjeeling, 2,100 m.</td>
<td>n=10</td>
<td>2x n=10: Mehra et al 1965.</td>
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<tr>
<td><em>Vicia indica</em> (Willd.) DC.</td>
<td>Couruttalum, 500 m.</td>
<td>n=9</td>
<td>2x n=9, 2n=27: Gupta 1969 Under V. auriculata Cass. n=9: Mehra et al 1965.</td>
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<tr>
<td><em>V. vestita</em> Benth.</td>
<td>Chandigarh, 240 m.</td>
<td>n=9</td>
<td>n=9: Mehra et al 1965.</td>
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<tr>
<td><em>Pulicaria vulgaria</em> Geertn.</td>
<td>Tathapani, 550 m.</td>
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<td>2x n=18: Wulff 1937</td>
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<tr>
<td><em>Carpesium cernum</em> Linn.</td>
<td>Tangmarg, 2000 m.</td>
<td>n=9</td>
<td>2n=18: Wulff 1937</td>
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<tr>
<td></td>
<td>Gulmarg, 2,700 m.</td>
<td>n=20</td>
<td>4x 2n=40: Arano 1962, Mehra et al 1965.</td>
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**Helianthaceae**

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<td><em>Acanthospermum hispidum</em> DC.</td>
<td>Kovalem, 0 m.</td>
<td>n=11</td>
<td>2x 2n=22: Mige 1960</td>
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<td>ploidy</td>
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<td>(Cult.)</td>
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<tr>
<td></td>
<td>Simla</td>
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<tr>
<td>Linn.</td>
<td>Rampur, 1,500 m.</td>
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<td>Tigershola, 1,500 m.</td>
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<td></td>
<td>Kotagiri, 1,950 m.</td>
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<td><em>Eclipta prostrata</em> (Linn.)</td>
<td>Chandigarh, 240 m.</td>
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<tr>
<td><em>Sclerocephalum africanus</em></td>
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<td>Jacq.</td>
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<tr>
<td><em>Blechnum latifolium</em></td>
<td>Kulathupuzha, 300 m.</td>
<td>n=17</td>
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<td>(Linn.f.) DC.</td>
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<td><em>Medalia chinensis</em> (Osbeck)</td>
<td>Veli, 0 m.</td>
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<td>Merr.</td>
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<td><em>N. hiflora</em> (Linn.) DC.</td>
<td>Kovalam, 0 m.</td>
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<td><em>N. affinis</em> DC.</td>
<td>Trivandrum, 0 m.</td>
<td>12</td>
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<td><em>Tithonia diversifolia</em> A. Grey</td>
<td>Sila, 2,200 m.</td>
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<td><em>I. setiflora</em> Desf.</td>
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<td><em>Sonanthea acmella</em> Linn.</td>
<td>Ponnudi, 1050 m.</td>
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<td><em>Synderele nodiflora</em> (Linn.) Gaertn.</td>
<td>Trivandrum, 0 m.</td>
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<td><em>Coronaria grandiflora</em> Hogg</td>
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<tr>
<td><em>Dahlia coccinea</em> Cav.</td>
<td>Mussoorie, 2,000 m.</td>
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<td><em>Cosmos bipinnatus</em> Cav.</td>
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<td>2</td>
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<td>Location</td>
<td>n</td>
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<tr>
<td>Bidens alternata (Lour.) Merr. &amp; Sherff.</td>
<td>Charabra, 2,600 m., Simla.</td>
<td>36</td>
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<td>Ketagiri, 1950 m., Nilgiris</td>
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<td>B. humilis H.B.K.</td>
<td>Ootacamund, 2,200 m., Nilgiris</td>
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<td>Galinsoga parviflora Cav.</td>
<td>Simla, 2,200 m., Darjeeling, 2,100 m.</td>
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<td>Iridect procumbens Linn.</td>
<td>Chandigarh, 240 m., Trivandrum, 0 m., Kerala.</td>
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<td>Heleneaeae</td>
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**ANTHEMIDEEAE**

### Achillea millefolium Linn.

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<tr>
<td>Gulumarg</td>
<td>2,700 m.</td>
<td>n=9</td>
<td>2n=36, 54: Turesson 1938, 2n=18: Felfoldy 1947, Harling 1950,</td>
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<td>2n=54: Ehrendorfer 1952, Love &amp; Love 1956, Jorgensen et al 1958,</td>
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<td>Khillenmarg</td>
<td>3,300 m.</td>
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<tr>
<td>Tangmarg</td>
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<tr>
<td>Pahalgam</td>
<td>1,800 m.</td>
<td>n=9</td>
<td>n=18: Ferris 1958, 2n=36: Ehrle 1958, Huziwara 1962, n=9: Shetty 1964,</td>
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<td>n=9, 2n=18: Mehra et al 1965.</td>
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<td>Khadralsa</td>
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<tr>
<td>Darjeeling</td>
<td>2,100 m.</td>
<td>n=27</td>
<td>2n=36: Packer 1964, n=9: Mehra et al 1965.</td>
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### A. sibirica Ledeb.

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<tr>
<td>Darjeeling</td>
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<td>2n=18: Harling 1950, Mulligan 1957.</td>
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### Anthemis cotula Linn.

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<tr>
<td>Simla</td>
<td>2,200 m.</td>
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<tr>
<td>Tangmarg</td>
<td>2,000 m.</td>
<td>n=9</td>
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### *A. fuscata* Brot.

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<tr>
<td>Pahalgam</td>
<td>1,800 m.</td>
<td>n=16</td>
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### Chrysanthemum leuconanthemum Linn.

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<tr>
<td>Harwan</td>
<td>1,650 m.</td>
<td>n=18</td>
<td>2n=36, 54: Dowrick 1952, 2n=18: Baksay 1956, Larsen 1965, 2n=36:</td>
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<td>Love &amp; Love 1956, Gadella &amp; Kliphuis 1963,</td>
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<tr>
<td>Tangmarg</td>
<td>2,000 m.</td>
<td>n=18</td>
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<tr>
<td>Gulumarg</td>
<td>2,700 m.</td>
<td>n=18</td>
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</table>
Simla, 2,200 m. n=18
Cherabra, 2,600 m. n=9 2x
Simla

G. saxinatum Scheousboe
Chandigarh, 240 m. n=9 2x
(Cult.)

G. coronarium Linn.
Chandigarh, 240 m. n=9 2x
(Cult.)

G. acutum Linn.
Darjeeling, 2,100 m. n=9 2x
(Cult.)

G. corymbosum Linn.
Tangmarg, 2,000 m. n=9 2x
Kashmir

†G. arifonse Heyata
Kotagiri, 1,950 m. n=9 2x
Nilgiris(Cult.)

†Tanacatum longifolium Wall.
Aporwet, 4,200 m. n=9 2x
Kashmir

†Artemisia parviflora
Buch.-Ham
Kodaikanal, 1,950 m. n=18 4x
Puineys

†A. scoparia Waldst. & Kit
Trivendrum, 0 m. n=9 2x
Kerala

2n=18, 36, 54: Rocher & Larsen 1957,
Mulligan 1958,
Gacek in Skalinska et al 1964,
n=9, 2n=18, 36, 54: Mulligan 1959,
2n=18, 36, c.54: Skalinska et al 1961,
2n=18, 36+18, 54+1-3B: Favarger 1963,
n=9, 18, 2n=36: Mehra et al 1965,
n=9: Powell & King 1969.

2n=18: Jain & Gupta 1960.
2n=18, 36: Shimotomai & Hara 1935,
n=9: Gupta 1969.
2n=18, 36: Dowrick 1952.
2n=18, 18+18, 36: Dowrick 1952.
Under C. indicum
2n=36, 54: Dowrick 1952,
2n=54: Tanaka 1955.

2n=9, 2n=18: Khosheo & Sobti 1958,
Koul 1964.

n=8, 2n=16: Khosheo & Sobti 1958,
2n=16, 36: Kawatani & Ohno 1964.
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<th>Location</th>
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<tbody>
<tr>
<td><em>A. vulgaris</em> Linn.</td>
<td>Devikulam, 1,200 m. Kerela</td>
<td>n=9 2x</td>
<td>2n=18: Weiniedel 1928, n=8: Keck 1946, 2n=16: Love &amp; Love 1956,</td>
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<td></td>
<td>Ponmudi, 1,050 m. Kerela</td>
<td>2n=45 5x</td>
<td>Gaddel &amp; Kipshuis 1963, Kawatani &amp; Ohno 1964,</td>
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<td><em>A. nilapirica</em> (Clarke) Pamp.</td>
<td>Simla, 2,200 m.</td>
<td>n=9 2x</td>
<td>n=8, 2n=16: Sorsa 1962, 2n=36, 54: Zhukova 1964,</td>
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<td><em>A. roxburghiana</em> Besser</td>
<td>Khillenmarg, 3,300 m. Kashmir</td>
<td>n=9 2x</td>
<td>n=8, 2n=16: Sorsa 1962, 2n=36, 54: Zhukova 1964,</td>
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<td><em>A. asperrum</em> Lab. var. vestita (DC.)</td>
<td>Rampur, 900 m. Simla</td>
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<td>n=8, 9, 2n=16, 18: Kou 1964, n=9: Mehra et al 1965,</td>
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<td><em>A. absinthium</em> Linn.</td>
<td>Kargil, 2,600 m. Ladhakh</td>
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<td>n=8, 2n=36, c 27: Estes 1968.</td>
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<td><em>Doronicum roylei</em> DC.</td>
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<td>n=30 2x</td>
<td>2n=18: Suzuka 1952-53, n=9, 18: 2n=18, 36: Khooshoo &amp; Sobti 1958,</td>
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<td><em>Oxylea nepalensis</em> DC.</td>
<td>Nainital, 2,000 m. Kumaon</td>
<td>n=10 2x</td>
<td>n=9: Khooshoo &amp; Sobti 1958, n=9, 2n=18: Kou 1958.</td>
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<td><em>E. tavanaica</em> (Burm.f.) Merr.</td>
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<td><em>S. denticulata</em> Buch.-Ham.</td>
<td>Darjeeling, 2,100 m.</td>
<td>Shale</td>
<td>1924</td>
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<td><em>S. acamptophylla</em> Desf.</td>
<td>Darjeeling, 2,100 m.</td>
<td>Schist</td>
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<td><em>S. crandallii</em> Don.</td>
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<td>Chlorite</td>
<td>1960</td>
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<td><em>S. alatus</em> Wall.</td>
<td>Chandigarh, 240 m.</td>
<td>Chlorite</td>
<td>1960</td>
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<td><em>S. asclepias</em> Linn.</td>
<td>Chandigarh, 240 m.</td>
<td>Chlorite</td>
<td>1960</td>
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<td><em>S. scutarius</em> DC.</td>
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<td>Chlorite</td>
<td>1960</td>
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<td>Chert</td>
<td>1960</td>
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<td><em>A. aromatica</em> DC.</td>
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<td>Sandstone</td>
<td>1960</td>
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**Notes:**
- **Shale:** 1,200 m.
- **Schist:** 2,200 m.
- **Chlorite:** 1,800 m.
- **Chert:** 2,000 m.
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<td><em>Cousinia microcarpa</em> Boiss.</td>
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<td>n=13, 2n=26: Koul 1964.</td>
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<td><em>Cnicus arvensis</em> Hoffm.</td>
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<td>n=17: Mehra et al 1965.</td>
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<td><em>C. acrocanthus</em> DC.</td>
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<td><em>C. wallichii</em> DC.</td>
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<td><em>Saussurea candicans</em> Clarke</td>
<td>Srinagar, 1,500m. Kashmir</td>
<td>16</td>
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<td>n=16: Mehra et al 1965.</td>
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<td><em>S. candida</em> Clarke</td>
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<td><em>Tricholenia stewartiae</em></td>
<td>Charabra, 2,600 m.</td>
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<td>n=8: Mehra et al 1965.</td>
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<td><strong>Clarke</strong></td>
<td>Simla</td>
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<td><em>I. elongata</em> DC.</td>
<td>Basantpur, 750 m.</td>
<td>16</td>
<td>4x</td>
<td>n=16: Mehra et al 1965.</td>
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<td><em>Carthamus tinctorius</em></td>
<td>Chandigarh, 240 m.</td>
<td>12</td>
<td>2x</td>
<td>2n=24: Poddubnaja 1931, n=12: Mehra et al 1965.</td>
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<td><strong>Linn.</strong></td>
<td>(Cult.)</td>
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<td><em>G. oxyacantha</em></td>
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<td>2n=24: Kishore 1951, n=12: Mehra et al 1965.</td>
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<td><em>G. lenatus</em></td>
<td>Srinagar, 1,500 m.</td>
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<td><em>Gerbera lanuginosa</em></td>
<td>Taradevi, 1,590 m.</td>
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<td>n=46: Mehra et al 1965.</td>
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<td><strong>Benth.</strong></td>
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<td><em>G. jamesonii</em></td>
<td>Darjeeling, 2,100 m.</td>
<td>25</td>
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<td>2n=50: Kishimoto 1936, n=25, 2n=50: Koul 1964, n=25: Mehra et al 1965.</td>
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<td><strong>Bolus.</strong></td>
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<td><em>Cichorium intybus</em></td>
<td>Srinagar, 1,500 m.</td>
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<td>n=9: Singh 1951, Mehra et al 1965, 2n=18: Stebbins et al 1953, Jaworska in Skalsinska et al 1964, n=9, 2n=18: Koul 1964.</td>
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<td><em>Lapsana communis</em></td>
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<td>2n=12: Love &amp; Love 1948, 2n=14: Stebbins et al 1953, n=8, 2n=16: Sorsa 1962, 1963.</td>
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<td>Nainital, 2,000 m. Kumon</td>
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<td>Younaria japonica (Linn.) DC.</td>
<td>Basanthpur, 750 m. Simla</td>
<td>n=8</td>
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<td>2n=16: Babcock 1937, Nisioka 1956, Borgmann 1964. Under Crepis japonica Benth.</td>
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<td><em>Crepis atoliczkei</em> Clarke</td>
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<td>n=3, 2n=6; Mehra et al 1965, n=5; Shetty 1967.</td>
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<td>Pterocephalus falconeri Hook.</td>
<td>Charabra, 2,600 m. Simla</td>
<td>n=3</td>
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<td><em>Hieracium croucatum</em> Fries</td>
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<td>2n=27</td>
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<td>Lockheartgap, 1,200 m. Kerala</td>
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<td><strong>H. radicata Linn.</strong></td>
<td>Coonoor, 1,950 m.</td>
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<td>Khadrara, 2,700 m.</td>
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<td>Dodabetta, 2,595 m.</td>
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<td><strong>L. dissecta D. Don.</strong></td>
<td>Basanthpur, 750 m.</td>
<td>n=8</td>
<td>2x</td>
<td>n=8: Mehra et al 1965, Shetty 1967.</td>
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<td><strong>L. longifolia DC.</strong></td>
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<td>2n=16: Stebbins et al 1953, n=8: Mehra et al 1965, Shetty 1967.</td>
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<td>Darjeeling, 2,100 m.</td>
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L. macrorhiza Hook
Simla, 2,200 m. n=8 2x n=8; 9: Mehra et al 1965, n=8; Shetty 1967.
Sonamarg, 2,500 m. n=8
Kashmir

Prenanthes brunoniana Wall.
Bhaqi, 2,600 m. n=8 2x n=8, 2n=16: Mehra et al 1965.
Simla

Picridium tinctum Desf.
Darjeeling, 2,100 m. n=9 2x n=9: Mehra et al 1965.


S. oleraceus Linn.
Kotagiri, 1,950 m. n=16
Nilgiris

S. arvensis Linn.
Simla

Lasnaga nudicaulis Hook.f.
Chandigarh, 240 m. n=9 2x 2n=18: Stebbins et al 1953, Jatindra Mohan et al 1962, n=9; Reese 1957, Mehra et al 1965.
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<td><em>L. sarmentosa</em> (Willd) Sch.-Bip</td>
<td>Kovalam, 0 m. Kerala</td>
<td>2n=18</td>
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<td>Under <em>L. pinnatifida</em> Cass. 2n=18: Jatindra Mohan <em>et al.</em> 1962.</td>
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<td><em>Scorzonera divaricata</em> Turez</td>
<td>Darass, 2,500 m. Ladakh</td>
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* Species investigated for the first time.
+ Cytotype investigated for the first time.
** Genus investigated for the first time.