Studies on the South Indian Compositae

III. Karyomorphology of nine species of *Blumea* DC.

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The study of morphology of chromosomes has gained a new sphere of usefulness in dealing with the systematic relationships, phylogeny and evolution of related plant groups, in addition to providing helpful clues as to the possible modes of karyotype variation within and between species. Although South India hosts a number of genera and species of the Compositae, our present knowledge on their karyomorphology is too fragmentary and isolated. During the cytological investigation on the family recently undertaken in this Department, chromosome studies were made in about 120 species belonging to 60 genera from South India. This includes detailed karyotype studies in a few genera. Preliminary chromosome reports on two genera have been made earlier (Mathew and Mathew 1975, 1976). This paper deals with the karyomorphology of nine species of *Blumea* (Inuleae), and the data briefly considered in relation to chromosome evolution in the genus.

Materials and methods

Species of the genus were collected from various low and high altitude localities in South India such as Kottayam, Trivandrum, Quilon, Ernakulam, Alwaye, Ranni, Munnar and Santhenpara. As far as possible materials of each of the taxa were studied from different localities. Somatic chromosomes were studied from root tip cells. Root tip cells were collected and pretreated with a 0.002 M solution of 8-hydroxyquinoline at 4°C for 2 hrs. They were then fixed in 3:1 Carnoy's fluid. For staining the chromosomes, haematoxylin was used throughout (Henderson and Lu 1968). Karyotype data were taken based on average measurements of chromosomes of 8–10 well-spread metaphase plates. Length of long arms (L) and short arms (S) were measured, and the arm ratios, relative chromosome length of different chromosomes, total complement length and size ratio (Longest-Shortest chromosome) were calculated. Classification of chromosomes in relation to their centromeric position was made according to the scheme proposed by Leven *et al.* (1964), and categorisation of karyotype asymmetry was made according to that of Stebbins (1958).

Observations

Blumea barbata DC.

Root tip cells showed 16 chromosomes at metaphase. They ranged in length

Chromosome	Chromosome length in μ			RCL	r	Centromere position
	Long arm	Short arm	Total			
1	5.83	3.09	8.92	18.02	1.89	sm
2	5.33	2.40	7.73	15.62	2.22	sm
3	4.17	2.90	7.07	14.28	1.44	m
4	3.67	1.43+0.67	5.77	11.66	1.78	sm sat
5	2.88	2.67	5.55	11.21	1.08	m
6	3.23	1.95	5.18	10.46	1.67	m
7	3.33	1.40	4.73	9.56	2.38	sm
8	2.92	1.63	4.55	9.19	1.79	sm
<i>B. membranacea</i> var. <i>gardneri</i>						
1	2.75	1.61	4.36	13.27	1.71	sm
2	2.25	2.00	4.25	12.97	1.13	m
3	2.30	1.75	4.05	12.35	1.31	m
4	2.00	1.85	3.85	11.71	1.08	m
5	1.80	1.75	3.55	10.84	1.03	m
6	2.00	1.40	3.40	10.34	1.34	m
7	1.70	1.50	3.20	9.74	1.13	m
8	1.61	1.50	3.11	9.47	1.07	m
9	1.75	1.31	3.06	9.33	1.34	m
<i>B. oxydonta</i>						
1	4.00+2.67	2.33	9.00	22.22	2.86	sm
2	4.70	2.13	6.93	16.86	2.21	sm
3	2.43	1.90	4.33	10.69	1.28	m
4	2.83	1.30	4.13	10.19	2.18	sm
5	2.37	1.43	3.80	9.38	1.67	m
6	1.87	1.77	3.64	8.99	1.06	m
7	2.00	1.50	3.50	8.64	1.33	m
8	1.70	1.63	3.33	8.22	1.04	m
9	1.67	1.23	2.94	7.26	1.36	m
<i>B. virens</i>						
1	3.08	1.58	4.66	14.93	1.97	sm
2	2.68	1.43	4.11	13.17	1.87	sm
3	1.93	1.83	3.76	12.05	1.05	m
4	2.52	0.88	3.40	10.89	2.85	sm
5	2.05	1.33	3.38	10.83	1.54	m
6	1.90	1.28	3.18	10.19	1.48	m
7	2.13	0.92	3.05	9.77	2.33	sm
8	2.12	0.90	3.02	9.36	2.24	sm
9	1.57	1.18	2.75	8.81	1.32	m
<i>B. wightiana</i>						
1	3.70	1.40	5.10	22.06	2.64	sm
2	3.07	1.10	4.17	18.04	2.79	sm
3	1.30	1.07	2.37	10.68	1.11	m
4	1.10	1.07	2.17	9.39	1.02	m
5	1.33	0.77	2.10	9.08	1.73	sm
6	1.03	0.93	1.96	8.52	1.11	m
7	0.97	0.95	1.92	8.30	1.02	m
8	1.00	0.72	1.72	7.48	1.37	m
9	0.83	0.68	1.51	6.57	1.22	m

from 3.05–6.37 μ , and consisted of 2 m-type and 6 sm-type pairs of chromosomes (Table 1 and Fig. 1). The karyotype belonged to the 2B category.

B. fistulosa (Roxb.) Kurz. (= *B. glomerata*)

Eighteen chromosomes were observed in the root tip cells at metaphase which ranged in length from 2.88–8.66 μ . Two pairs were distinctly larger than the rest. The karyotype consisted of 1 M-type, 5 m-type and 3 sm-type pairs of chromosomes, and it belonged to the 2B category (Table 1 and Fig. 2). The 1st, 2nd and 7th pairs of chromosomes possessed secondary constrictions on their long arms.

Figs. 7–9. Idiograms of three species of *Blumea*. 7, *Blumea lacera* var. *glandulosa*, $n=18$. 8, *B. virens*, $n=9$. 9, *B. wightiana*, $n=9$.

B. jacquemontii Hook f.

Root tip cells of this species showed 18 chromosomes at metaphase which ranged in length from 2.2–6.8 μ . Here also two pairs were larger in size. Chromosome No. 2 possessed a secondary constriction on the long arm. The karyotype consisted of 7 pairs of m-type and 2 of sm-type chromosomes, and it belonged to the 2B category (Table 1 and Fig. 3).

Figs. 1–6. Idiograms of six species of *Blumea*. 1, *Blumea barbata*, $n=8$. 2, *B. fistulosa*, $n=9$. 3, *B. jacquemontii*, $n=9$. 4, *B. malcolmei*, $n=8$. 5, *B. oxyodonta*, $n=9$. 6, *B. membranacea* var. *gardneri*, $n=9$.

B. lacera DC. var. *glandulosa*

Thirty-six chromosomes were observed in the root tip cells at metaphase. They ranged in length from 2.08–6.64 μ . The karyotype consisted of 12 pairs of m-type, 4 of sm-type and 2 of st-type chromosomes (Table 1 and Fig. 7). The third pair of chromosomes showed a secondary constriction on the long arm. Here also the somatic complement exhibited recognisable bimodality, in which four pairs were large sized and the rest distinctly smaller. The karyotype belonged to the 2B category.

Miyagi (1971) reported $2n=18$ for *B. lacera* and the present cytotype is a new report for this taxon.

B. malcomei Hook f.

At metaphase the root tip cells showed 16 chromosomes which ranged in length from 4.55–8.92 μ . The chromosomes were recognizably larger than the other diploid species and it possessed a total chromosome size of 99 μ . Chromosome No. 4 possessed a globular satellite on the short arm. The karyotype consisted of 3 pairs of m-type and 5 of sm-type chromosomes (Table 1 and Fig. 4), and it belonged to the 2A category.

B. membranacea DC. var. *gardneri*

Root tip cells showed 18 chromosomes at metaphase, ranging in length from 3.06–4.36 μ . The chromosomes were much smaller in size than the other diploid species. The karyotype is of the 1A category, and consisted of 8 pairs of m-type and 1 of sm-type chromosomes (Table 1 and Fig. 6).

B. oxydonta DC.

Root tip cells of this species showed 18 chromosomes at metaphase, ranging in length from 2.94–9.0 μ . Two pairs were distinctly larger in size, and both of them possessed secondary constrictions on the long arms. The karyotype consisted of 6 pairs of m-type and 3 of sm-type chromosomes (Table 1 and Fig. 5) and belonged to the 2B category.

B. virens DC.

Eighteen chromosomes were observed in the root tip cells at metaphase which ranged in size from 2.75–4.66 μ . The karyotype belonged to the 2A category, and it consisted of 4 pairs of m-type and 5 of sm-type chromosomes (Table 1 and Fig. 8).

B. wightiana DC.

Root tip cells showed 18 chromosomes at metaphase, and they ranged in size from 1.51–5.1 μ . The somatic chromosomes apparently fall under two size classes, two pair being distinctly larger in size. The karyotype consisted of 6 pairs of m-type and 3 of sm-type chromosomes (Table 1 and Fig. 9), and it belonged to the 2B category.

Discussion

Chromosome data on *Blumea* show that the genus is multibasic ($x=8, 9, 10, 11$).

Bulk of the South Indian species examined by us and also those reported by others from this region (Chennaveeraiah and Patil 1972) are based on $x=9$, with only two species reported here, namely *B. barbata* and *B. malcolmei* showing $x=8$. The other two basic numbers ($x=10$ and 11) are common among the North Indian taxa (Mehra *et al.* 1965, Gupta 1969). In an earlier report we had suggested (Mathew and Mathew 1975) that in *Blumea* $x=10$ could be the earlier evolved condition from which the other constitutions evolved by incidence of aneuploidy in either direction. It was also postulated that the $x=10$ condition could be of polyploid origin from ancestral taxa with $n=5$.

Karyomorphology of species reported here show that karyotypes of both the $x=9$ and $x=8$ species of *Blumea* are moderately asymmetrical (2A and 2B), and it appears that the pattern of karyotype variation among the South Indian group of species of this genus is one of decreasing basic number unassociated with change in karyotype asymmetry. However, in finer details of chromosome morphology, the karyotypes of the $x=9$ species in general are more asymmetrical. Morphological changes of chromosomes involving shift of centromere position in the $x=9$ group have occurred mainly in five chromosomes (Fig. 10), such as chromosomes 1, 2, 4,

Fig. 10. Arm ratios in six $x=9$ species of *Blumea*.

7 and 8, while shift of centromeric position of a comparable magnitude does not seem to have occurred in the $x=8$ species (Fig. 11). The fact that species with the derived $x=8$ constitution to possess less specialised karyotypes as compared to those of their $x=9$ progenitors apparently presents a strange situation. A possible explanation for this is that the karyotypes of the South Indian species of *Blumea* could have been relatively less asymmetrical and unspecialised before the numerical change from $x=9$ to $x=8$ had occurred, and that since the numerical change, the structural changes in chromosomes leading to karyotype asymmetry must have

been more active in the $x=9$ group.

The chromosome measurements of the $x=9$ species show that many of them exhibit appreciable intrakaryotypic size difference. In four of the diploid species, namely *B. fistulosa*, *B. jacquemontii*, *B. oxydonta* and *B. wightiana*, chromosomes 1 and 2 are remarkably larger in size than the rest of the chromosomes such that

Fig. 11. Arm ratios in two $x=8$ species of *Blumea*.

their karyotypes can be considered as bimodal. In the $x=9$ tetraploid species, *B. lacera* var. *glandulosa* also such a bimodality is recognizable. Here, four pairs of chromosomes are clearly larger than the rest. According to Lewitzky (1931), bimodality arises as a result of periodical unequal translocations between non-homologous chromosomes such that the donors gradually become smaller and the recipients correspondingly larger. In such cases the number of short chromosomes will be approximately equal to that of the larger ones (Stebbins 1971). But, in the present species with bimodal karyotypes, the short chromosomes greatly outnumber the longer ones (7:2), and hence it appears that unequal translocations alone cannot account for the higher incidence of short chromosomes. Darlington's (1963) postulation regarding the origin of bimodal karyotypes is relevant here. According to him, bimodality originates from symmetrical karyotypes of species of polyloid origin which have many gene loci in duplicate so that loss of segments of chromosomes may be tolerated. In this connection, our earlier suggestion of polyploid origin of the present-day diploid species of *Blumea* from ancestral taxa with $n=5$ is interesting (Mathew and Mathew 1975), and it is possible that in the origin of bimodality in species of *Blumea*, loss of chromosome segments also must have been strongly operative.

Of the seven $x=9$ species reported here, two species which do not show bimodality are the ones which show least asymmetry of the karyotypes, namely *B. virens* (2A) and *B. membranacea* var. *gardneri* (1A). It may be noted here that

among the $x=9$ species, those with bimodal karyotypes are found to show more advanced morphological features than those which possessed graded karyotypes. In the latter group, there was larger plant size, corymbosely branched open flowering stems and long peduncled heads. This situation appears to indicate that in the $x=9$ group of species of *Blumea*, morphological advancement has accompanied karyotype specialization.

Summary

Karyomorphology of nine species of *Blumea* has been presented such as *B. barbata* ($2n=16$), *B. fistulosa* ($2n=18$), *B. jacquemontii* ($2n=18$), *B. lacera* var. *glandulosa* ($2n=36$), *B. malcolmei* ($2n=16$), *B. membranacea* var. *gardneri* ($2n=18$), *B. oxyodonta* ($2n=18$), *B. virens* ($2n=18$) and *B. wightiana* ($2n=18$).

Karyotypes of both the $x=9$ and $x=8$ species are moderately asymmetrical (2A and 2B). In finer details, the karyotypes of $x=9$ species are seen to be more specialized. Five $x=9$ species showed bimodal karyotypes and in all of them the short chromosomes greatly outnumbered the long ones.

Species possessing bimodal karyotypes showed more advanced morphological characters, and this appears to indicate an association between karyotype specialization and morphological advancement of plants in the genus.

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