Proc. Indian Acad. Sci. (Plant Sci.), Vol. 94, Nos 4-6, June 1985, pp. 619-626

Cytological studies on members of family Labiatae from Kodaikanal and adjoining areas (South India)

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MS received 5 May 1984; revised 10 January 1985

Abstract. Chromosomal analysis of 33 species of Labiatae from South India have indicated that 23·53 % are polyploids. Several taxa are investigated for the first time. Analysis of results in totality for the region indicates that shrubby and perennial species have higher incidence of polyploidy. Polybasic nature of the family as well as the investigated taxa is quite apparent and this indicates the role of eu- and aneuploidy in evolution of various taxa in the family.

Keywords. Chromosome numbers; Labiatae; polyploidy; polybasic.

1. Introduction

South India is one of the major centres of distribution of members of family Labiatae in India since it supports over 139 species (Mukerjee 1940). Cytologically, Labiates of South India have not hitherto attracted much attention. Barring the chromosome number reports by Vembu and Sampathkumar (1978, 1980), Cherian and Kuriachan (1981), and Krishnappa and Indiramma (1982), no significant work has been done so far. Therefore, the present studies were carried out as a part of our project on Indian Bicarpellatae.

2. Material and methods

Materials for the present studies were collected from Kodaikanal (10° 13′N lat. and 77° 32′ E long.), a hill resort in Madurai district of Tamil Nadu, and its surroundings between altitudinal range of 300–2400 m. The specific localities for the materials of various taxa are mentioned in table 1. Meiotic studies were made following the usual acetocarmine squash techniques after fixations of young flower buds in Carnoy's fluid. Voucher specimens are preserved in PUN.

3. Observations

Presently, 33 species (34 taxa) belonging to 13 genera are chromosomally analysed and the obtained information is provided in table 1. In each case several populations were studied so as to arrive at the exact chromosome number and follow the meiotic process leading to pollen formation. In majority of the cases meiosis is normal leading to the formation of normal, apparently, viable pollen. However, in few cases, certain meiotic abnormalities have been observed as per details that follow. Information on palynology has been published elsewhere (Saggoo and Bir 1983).

Table 1. Chromosome numbers in South Indian Labiatae.

Name of Taxa 1	Localities† 2	Chromosome numbers+ 3	Ploidy level 4	PUN Accession number(s) 5
Anisomeles indica O. Ktze.	I*a*	$n = 17$ (figure 1)	Diploid	27036
A. malabarica R. Br.	I*b, c*	$n = 17$ (figure 2)	Diploid	27247, 26931
Calamintha umbrosa Fisch. & Mey	I*d*	$n = 19$ (figure 3)	Tetraploid (aneuploid)	27117
Coleus aromaticus Benth.	I*e*	$n = 17$ (figure 4)	Diploid	26915
C. blumei Benth.	I*f*	$n = 24$	Tetraploid	27844
C. forskohlii Briq.	I*f, g*	$n = 15$ (figure 5)	Diploid	27031, 27254
C. malabaricus Benth.	I*h*	$n = 14$	Diploid	26958
Dysophylla auricularia Bl.**	I*a*	$n = 17$ (figure 20)	Hexaploid (aneuploid)	27252
Hyptis suaveolens Poit.	I*a*	$n = 14$ (figure 6)	Diploid	27130
Micromeria biflora Benth.	I*i*	$n = 15$	Diploid	27123
Ocimum adscendens Willd.	I*e*	$n = 11$ (figure 7)	Diploid	26964
O. basilicum Linn.	I*e*	$n = 24$	Tetraploid	27237
O. canum Sims.	I*e*	$n = 13$	Diploid	26961
O. kilimandscharicum Guerke	I*j*	$n = 38$	Tetraploid	27265
O. sanctum Linn. var. *hirsuta* Hook. f.*	I*c*	$n = 18$ (figure 8)	Tetraploid	26966
Orthosiphon glabratus Benth.	I*k*	$n = 13$	Diploid	26941
O. pallidus Royle	I*l*	$n = 14$ (figure 9)	Diploid	26929
O. tomentosus Benth.*	I*b*	$n = 13$ (figure 21)	Diploid	26940
var. *tomentosa* Hook. f.*	I*f*	$n = 13$ (figure 10)	Diploid	27250
Plectranthus fruticosus Wight**	I*i*	$n = 28$ $2n = 56$ (figure 22)	Tetraploid	26868
P. macraei Benth.*	I*g, f*	$n = 12$ (figure 11)	Diploid	26969, 27032
P. mollis Spreng.	I*m*	$n = 14$ (figure 12)	Diploid	27259
P. nilghiricus Benth.	I*i*	$n = 12$ (figure 13)	Diploid	26972
P. stocksii Hook. f.*	I*n*	$n = 12$ (figure 24)	Diploid	26974
P. wightii Benth.	I*n, o*	$n = 12$ (figure 14)	Diploid	26930, 26925
Pogostemon paludosus Benth.*	I*i, p*	$n = 17$ (figure 15)	Diploid	26905, 27042
P. pubescens Benth.*	I*h*	$n = 16$ (figure 16)	Diploid	20827
Prunella vulgaris Linn.	I*q*	$n = 14$	Diploid	27172
Salvia coccinea Juss.	I*j*	$n = 11$ (figure 17)	Diploid	26872

Table 1 (*Continued*)

Name of Taxa 1	Localities† 2	Chromosome numbers⁺ 3	Ploidy level 4	PUN Accession number(s) 5
S. grahmi Benth.	I*p*, II*a*	$n = 11$ (figure 18)	Diploid	26883, 27241
S. splendens Sello	I*n*	$n = 22$	Tetraploid	27262
Scutellaria colebrookiana Benth.*	I*f*	$n = 13$ (figure 25)	Diploid	26918
S. violacea Heyne*	I*i*	$n = 13$ (figure 19	Diploid	26895
S. wightiana Benth.*	III*a*	$n = 13$ (figure 26)	Diploid	26919

† Localities: I, Kodaikanal: *a*, Perumalmalai, 1600m; *b*, Amsapuram, 300m; *c*, Kodaikanal Road, 250m; *d*, Shembaganur, 1850m; *e*, Fall's view, 900m; *f*, Palmalai, 1200m; *g*, Kodaikanal town, 2050m; *h*, Tiger shola, 1800m; *i*, Bear shola, 1900m; *j*, Malayadumparai, 1500m; *k*, Pholather, 1100m; *l*, Palni, 300m; *m*, Uttoo, 1200m; *n*, Pillar rocks, 2200m; *o*, Vellagavie, 1600m; *p*, Kodai shola, 2100m; *q*, Berijam, 2400m. II. Ootacamund: *a*, Botanical Garden, 2400m. III. Kumali (Kerala): *a*, Thekkadi, 950m.

⁺ For previous reports reference is made to Darlington and Wylie (1955), Löve and Löve (1961, 1974, 1975), Fedorov (1969), Index to plant chromosome numbers (1956 onwards), IOPB chromosome number reports (1965 onwards) and selected references from Biological Abstracts up to the end of 1983.

* Worked out for the first time.

** Different reports.

3.1 *Plectranthus fruticosus*

In *P. fruticosus* ($2n = 56$) meiosis is highly abnormal with 83·1 % of the PMCs showing 4–6 univalents (figure 22). Average frequency of bivalents and univalents per PMC is 25·81 % and 4·37 %, respectively (table 2). The most common configuration is $25_{II} + 6_{I}$ being represented in 32·11 % of PMCs at *M*-I. Other chromosomal configurations are $26_{II} + 4_{I}$ (figure 22) and 28_{II} in 30·99 % and 16·99 %, respectively, of the observed PMCs at *M*-I. Invariably univalents lag at *A*-I/*T*-I. Few (4·32 %) PMCs show formation of bridges or lagging of one bivalent along with univalents (figure 23). Laggards form micronuclei which lead to polyad formation in 81·6 % of the PMCs resulting in only 37·8 % fertile and apparently viable pollen grains.

3.2 *Scutellaria colebrookiana*

In *S. colebrookiana* ($n = 13$) 26·19 % of the PMCs observed at *M*-I show precocious disjunction of one bivalent but without affecting the future course of meiosis. In few PMCs of another species of the genus, *S. wightiana* ($n = 13$), 1–2 bivalents show late disjunction at *A*-I (figure 27). Here, too, the further course of meiosis is normal.

4. Discussion

Cumulative cytological data on the genus *Ocimum* reveal its polybasic nature ($x = 8$, 11, 12, 13, 19). Singh and Sharma (1982) suggested $x = 8$ and 12 as the two primary

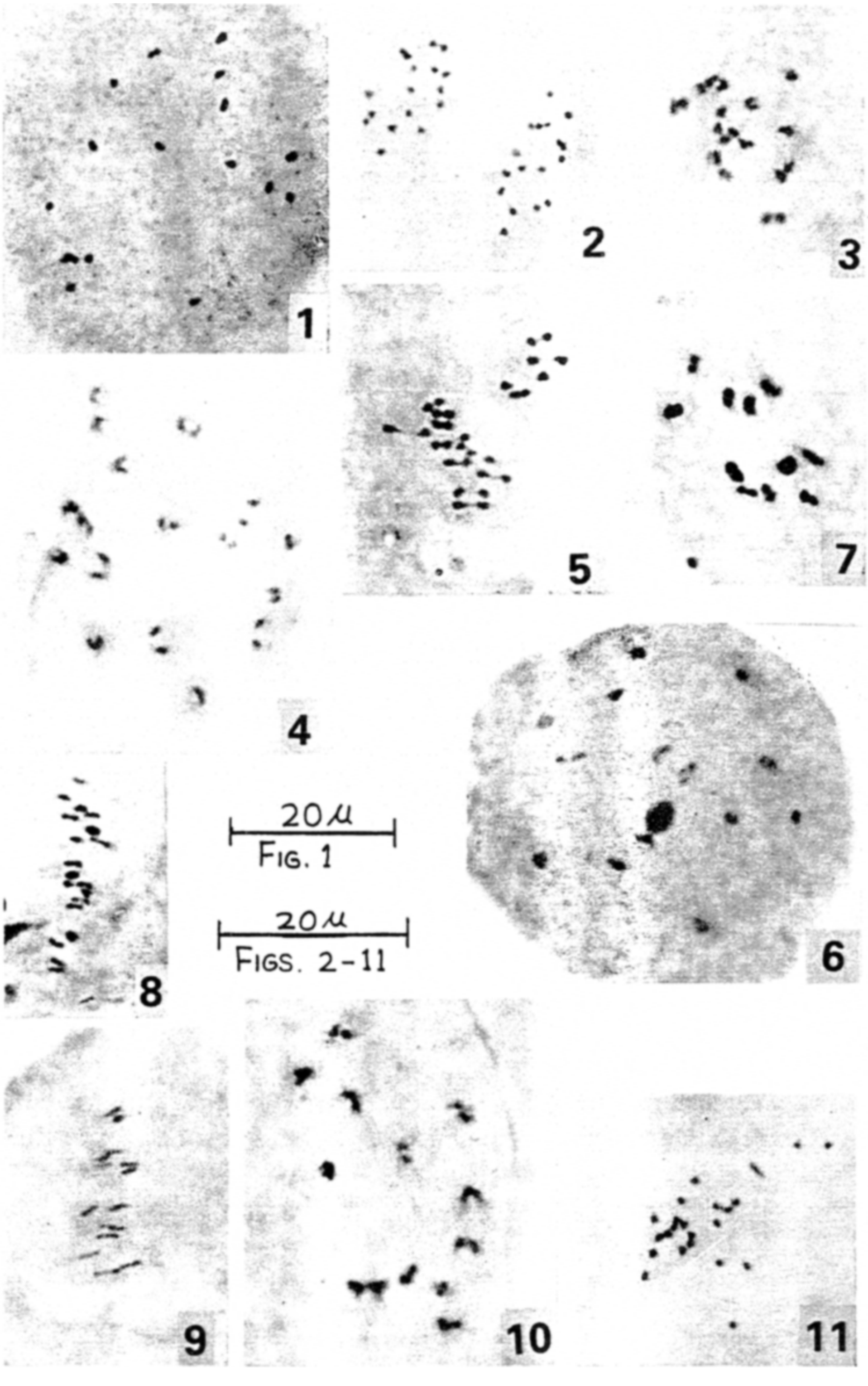
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Table 2. Chromosomal associations at *M*-I in *Plectranthus fruticosus* Wight.

Number of PMCs	Percentage	Univalents	Bivalents
37	52·11	6	25
22	30·99	4	26
12	16·90	0	28
Total: 71	100·00	310	1833
Average/PMC	–	$4{\cdot}37_{I}$	$25{\cdot}81_{II} = 2n = 56$

basic numbers. Among the presently investigated species, *O. adscendens* ($2n = 22$) and *O. canum* ($2n = 26$) are diploids based on $x = 11$ and 13, respectively, while *O. basilicum* ($2n = 48$) and *O. kilimandscharicum* ($2n = 78$) are tetraploids based on $x = 12$ and $x = 19$, respectively. *O. sanctum* var. *hirsuta* with $n = 18$ is an aneuploid at tetraploid level.

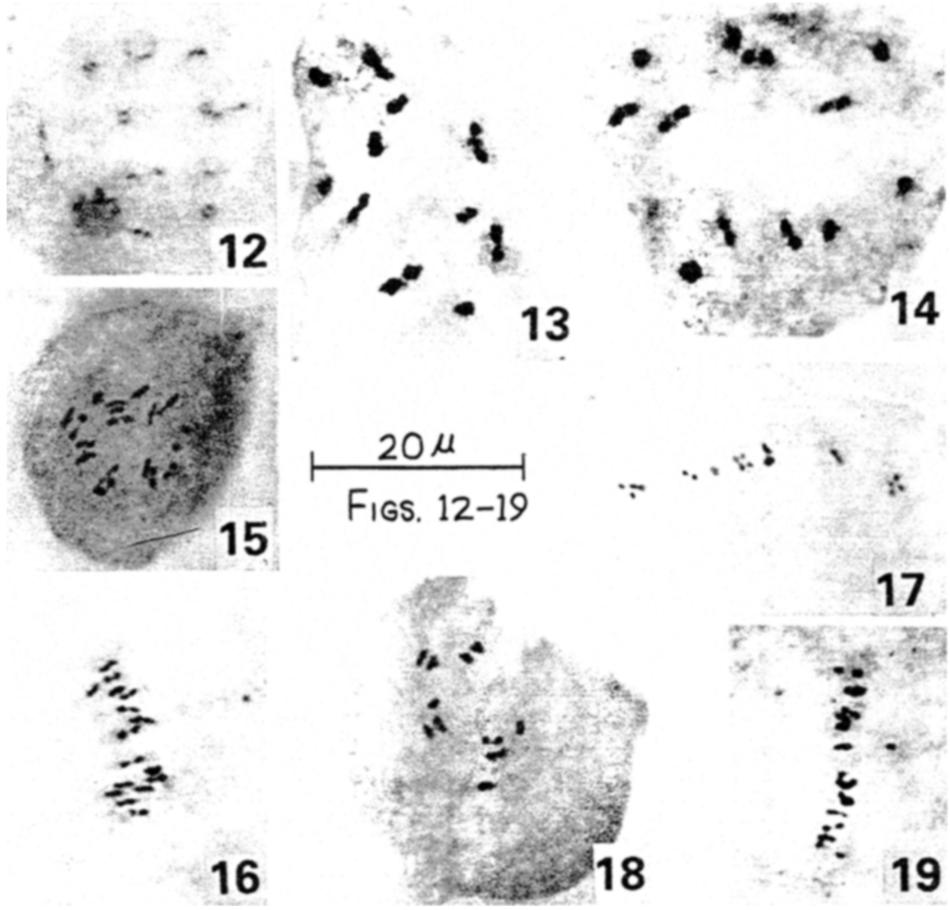
All the three investigated species of the genus *Orthosiphon* are at diploid level. *O. glabratus* and *O. tomentosus* are based on $x = 13$ while *O. pallidus* is based on $x = 14$. So far, eight species of the genus are known chromosomally, clearly indicating the polybasic nature of the genus ($x = 11$, 12, 13, 14).

Both the species of *Pogostemon*, namely, *P. pubescens* ($n = 16$) and *P. paludosus* ($n = 17$) are diploid based on $x = 16$ and 17, respectively. Gill (1971) is of the view that $x = 8$ is the original base number for the genus, however, Bir and Saggoo (1982) suggested $x = 16$ and 17, though of secondary origin. Out of six species of *Plectranthus*, four species *viz. P. macraei* ($n = 12$), *P. nilghiricus* ($n = 12$), *P. stocksii* ($n = 12$) and *P. wightii* ($n = 12$) are diploid based on $x = 12$. The other two *viz. P. mollis* and *P. fruticosus* are based on $x = 14$. The former with $n = 14$ is diploid while the latter with $n = 28$, is tetraploid. This is an unbalanced polyploid since the presence of up to 6_{I}s is of frequent occurrence. The existence of the tetraploid cytotype of *P. fruticosus* is recorded for the first time. Earlier, de Wet (1958) and Morton (1962) reported from Africa diploid plants of the species with $2n = 28$.

Dysophylla auricularia with $2n = 34$ is also studied for the first time from India and is in line with the earlier report by Chaung *et al* (1963) from Taiwan. Hsu (1967), also from Taiwan, however, recorded $2n = 12$ for the species. Taking $x = 6$ as its base number the presently worked out taxon is an aneuploid at hexaploid level.

The genus *Scutellaria* is polybasic with base number $x = 8$, 11, 12, 13, 15 and 17 (Gill 1970). The presently studied species *viz. S. colebrookiana*, *S. violacea* and *S. wightiana*

Figures 1–11. Meiosis in pollen mother cells (PMCs). **1.** *Anisomeles indica* ($n = 17$): *M*-I showing 17_{II}. **2.** *A. malabarica* ($n = 17$): *A*-I showing 17 + 17 chromosomes. **3.** *Calamintha umbrosa* ($n = 19$): 19_{II} at diakinesis. **4.** *Coleus aromaticus* ($n = 17$): Diakinesis showing 17_{II}. **5.** *C. forskohlii* ($n = 15$): *M*-I with few bivalents already disjuncted. **6.** *Hyptis suaveolens* ($n = 14$): 14_{II} at diakinesis. **7.** *Ocimum adscendens* ($n = 11$): *M*-I with 11_{II}. **8.** *O. sanctum* var. *hirsuta* ($n = 18$): *M*-I showing 18_{II}. **9.** *Orthosiphon pallidus* ($n = 14$): 14_{II} at *M*-I. **10.** *O. tomentosus* var. *tomentosa* ($n = 13$): Diakinesis showing 13_{II}. **11.** *Plectranthus macraei* ($n = 11$): Mixed *A*-I showing 24 chromosomes.

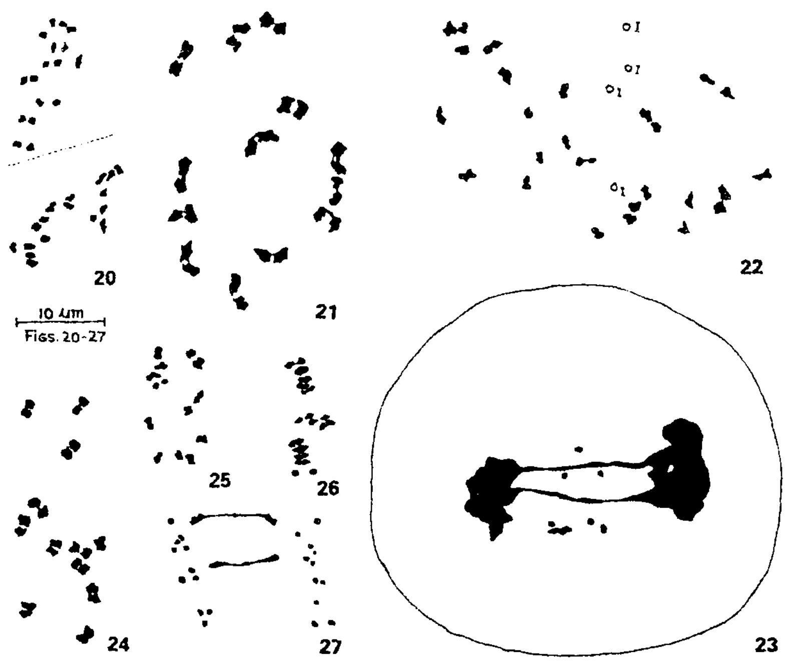


Figures 12–19. Meiosis in PMCs. **12.** *Plectranthus mollis* ($n = 12$): 12_{II} at diakinesis. **13.** *P. nilghiricus* ($n = 12$): Diakinesis with 12_{II}. **14.** *P. wightii* ($n = 12$): 12_{II} at diakinesis. **15.** *Pogostemon paludosus* ($n = 17$): *M*-I showing 17_{II}. **16.** *P. pubescens* ($n = 16$): 16_{II} at *M*-I. **17.** *Salvia coccinea* ($n = 11$): *M*-I with 11_{II}. **18.** *S. grahmi* ($n = 11$): 11_{II} at *M*-I. **19.** *Scutellaria violacea* ($n = 13$): *M*-I showing 13_{II}.

are diploid based on $x = 13$. Three species of *Coleus* namely, *C. malabaricus* ($n = 14$), *C. forskohlii* ($n = 15$) and *C. aromaticus* ($n = 17$) are diploid based on $x = 14$, 15 and 17, respectively, while *C. blumei* ($n = 24$) is tetraploid based on $x = 12$. The genus is polybasic with $x = 12$, 14, 15, 16, 17, 18.

A perusal of literature reveals the existence of discordant chromosome numbers pointing towards the polybasic nature of the family. This further indicates the role of eu- and aneuploidy in the origin of various taxa of the family.

Of the presently investigated 33 species, eight are polyploids (23·53 %). To date, chromosome counts of 70 species of Labiatae are known from South India. Out of these only 12 (17·14 %) are polyploids. Intraspecific aneuploid cytotypes have been recorded in 14·28 % of Labiates from South India. So far, intraspecific polyploidy is reported only in *Coleus blumei* ($2x$, $4x$, $6x$) by Reddy (1952). Correlating the incidence



Figures 20–27. Meiosis in PMCs. **20.** *Dysophylla auricularia* ($n = 17$): *M*-II with 17 + 17 chromosomes. **21.** *Orthosiphon tomentosus* ($n = 13$): 13_{II} at diakinesis. **22–23.** *Plectranthus fruticsus* ($2n = 56$): 22, *M*-I with 26_{II} and 4_I; **23.** *T*-I with bridges along with one bivalent and other laggards. **24.** *P. stocksii* ($n = 12$): 12_{II} at *M*-I. **25.** *Scutellaria colebrookiana* ($n = 13$): *M*-I with 13_{II}. **26, 27.** *S. wightiana* ($n = 13$) **26.** *M*-I showing 13_{II}. **27.** *A*-I with late disjunction in two bivalents.

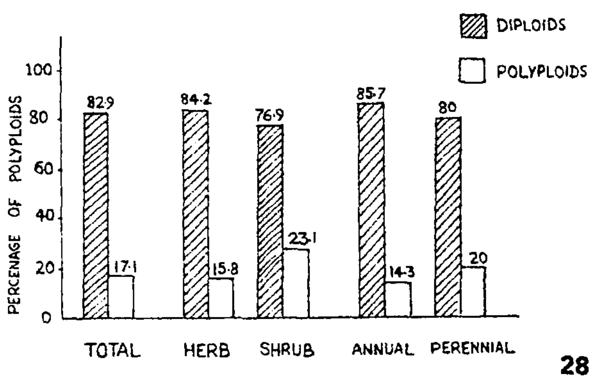


Figure 28. Correlation of the life-form and polyploidy in the South Indian Labiatae.

of polyploidy with life form, it is quite clear that shrubby and perennial species have higher incidence of polyploidy as compared to the herbaceous and annual members (figure 28).

Acknowledgements

One of the authors (MISS) is grateful to CSIR., New Delhi for the award of a Research Fellowship.

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