Inter-specific Variations in Chiasma Frequencies and Terminalization in *Chlorophytum* Ker-Gawl.

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The genus *Chlorophytum* Ker-Gawl. belongs to the tribe Anthericinae of the sub-family Asphodeleae of Liliaceae (Engler and Prantl 1930), comprising of about 234 species distributed in tropical and sub-tropical regions. Earlier work on this genus appears to be restricted to chromosome number and morphology (Baldwin and Speese 1951, Boraiah 1966, Datta and Mitra 1968, Sheriff 1967, 1971, Sheriff and Chennaveeraiah 1975, Naik 1976, 1977). Relatively very little information is available on the meiotic chromosome behaviour in the species of this genus. Earlier workers have reported meiosis to be regular with eight bivalents in *C. tuberosum* and *C. laxum* (Datta and Mitra 1968, Boraiah 1966, Sheriff and Chennaveeraiah 1975, Naik 1976, 1977). In *C. tuberosum* Kumar and Rao (1958) have reported chiasma frequency per bivalent, interstitial chiasmata, total chiasmata, and chiasmata per bivalent. Hence, the authors have attempted to study chiasma frequency at late diplotene/dikinesis and metaphase I and coefficient of terminalization in five species of *Chlorophytum*.

Materials and methods

Chiasma frequencies in the following *Chlorophytum* species have been carried out:

Species	Locality
<i>C. laxum</i> R. Br.	Poona University campus
<i>C. tuberosum</i> Baker	Poona University campus
<i>C. comosum</i> Jacques.	Garden plant
<i>C. glaucum</i> Dalz.	Ganapati Pule, Konkan
<i>C. orchidastrum</i> Lindl.	Purandhar Fort

Anthers at proper stage were squashed in 0.01 acetocarmine; late diplotene/dikinesis and metaphase I plates showing well separated bivalents were sketched at bench level using fluotar oil immersion objective. Data have been recorded from semipermanent preparations.

Results

Data recorded suggest the number of bivalents to vary in these five species.

Species	No. of bivalents
<i>C. laxum</i>	8
<i>C. tuberosum</i>	8
<i>C. comosum</i>	14
<i>C. glaucum</i>	21
<i>C. orchidastrum</i>	21

a) Chiasma frequency at late diplotene/dikinesis

Total number of chiasmata per PMC ranges from 19.4 to 52.2, maximum being in *C. glaucum* and minimum in *C. laxum* (Table 1). These variations within the genus might be due to polyploidy present as observed above. However, number of chiasmata per bivalent indicates

Table 1. Chiasma frequencies in *Chlorophytum* species at diplotene/diakinesis

Species	No. of PMCs analysed	No. of bivalents	No. of bivalents with chiasmata					Total no. of X-ta/PMC	Total bivalent length/PMC (μ m)	Mean bivalent length/unit X-ma	No. of X-ta/bivalent	No. of X-ta/100 μ m bivalent length
			1	2	3	4	5					
<i>C. laxum</i>	10	8	0.8	3.5	3.2	0.5	—	19.4	71.28	3.67	2.43	27.22
<i>C. tuberosum</i>	10	8	0.5	1.6	3.2	2.4	0.3	24.4	75.10	3.08	3.05	32.49
<i>C. comosum</i>	25	14	—	10.76	2.96	0.28	—	31.52	95.60	3.03	2.25	32.97
<i>C. glaucum</i>	10	21	1.2	9.6	9.0	1.2	—	52.2	125.73	2.41	2.49	41.52
<i>C. orchidastrum</i>	15	21	3.13	10.93	5.87	1.0	—	46.6	131.72	2.83	2.22	35.38

Table 2. Chiasma frequencies in *Chlorophytum* species at metaphase

Species	No. of PMCs analysed	No. of bivalents	No. of bivalents with chiasmata/PMC					Total no. of X-ta/PMC	Total bivalent length/PMC (μ m)	Mean bivalent length/unit X-ma	No. of X-ta/bivalent mean	No. of X-ta/100 μ m bivalent length
			0	1	2	3	4					
<i>C. laxum</i>	20	8	0.05	1.30	3.55	2.60	0.50	18.20	32.61	1.79	2.275	55.81
<i>C. tuberosum</i>	20	8	—	0.45	2.70	3.95	0.90	21.30	51.40	2.41	2.663	41.44
<i>C. comosum</i>	20	14	0.10	1.40	9.90	2.35	0.25	29.25	52.03	1.78	2.089	56.22
<i>C. glaucum</i>	10	21	0.60	0.90	9.10	9.60	0.70	50.70	77.70	1.53	2.414	65.25
<i>C. orchidastrum</i>	15	21	1.80	3.0	9.46	5.80	0.93	43.07	54.26	1.26	2.05	79.38

highest values in *C. tuberosum* followed by *C. glaucum* and minimum in *C. orchidastrum*. Number of chiasmata per 100 μ m of bivalent length is highest in *C. glaucum* and lowest in *C. laxum*. Bivalents with 1 to 5 chiasmata vary in individual species. It is interesting to note that in *C. tuberosum* bivalents with five chiasmata could be observed. Even the number of bivalents with three chiasmata appears to be more in *C. tuberosum*.

b) *Chiasma frequency at metaphase I*

Like diplotene, the total number of chiasmata per PMC varies from 18.2 to 50.7, highest being in *C. glaucum* and lowest in *C. laxum*. Maximum number of bivalents with zero chiasma is recorded in *C. orchidastrum*, whereas in *C. tuberosum*, this category was not represented. Reversely, more number of bivalents with four chiasmata are noted in *C. orchidastrum* (Table 2).

Number of chiasmata per bivalent and mean bivalent length per unit chiasma appear to follow the same trends like diplotene (highest in *C. tuberosum* and lowest in *C. orchidastrum*).

c) *Coefficient of terminalization*

At diplotene, the number of interstitial chiasmata was more in *C. glaucum* (11.40). In *C. comosum*, these values were the lowest (Table 3). Similar trends have been observed for interstitial chiasmata at metaphase I. It is conspicuous to note that the number of interstitial chiasmata at diplotene and metaphase I appears to be more or less same in *orchidastrum* and *glaucum* suggesting the possibility of stationary or non-random movement of chiasmata. On the other hand, in remaining species there is decrease in number of interstitial chiasmata at metaphase I.

Table 3. Coefficient of terminalization in *Chlorophytum* species

1 Species	2				3				4 Coefficient of termina- lization 3c/2c
	Mean chiasma frequency per PMC at diplotene/diakinesis				Mean chiasma frequency per PMC at metaphase I				
	Inter- stitial a	Terminal b	Total c	2b/2c	Inter- stitial a	Terminal b	Total c	3b/3c	
<i>C. laxum</i>	4.20	15.20	19.40	0.7835	3.60	14.60	18.20	0.8022	0.9381
<i>C. tuberosum</i>	8.90	15.50	24.40	0.6352	5.75	15.55	21.30	0.7300	0.8730
<i>C. comosum</i>	3.52	28.00	31.52	0.8883	2.85	26.40	29.25	0.9026	0.9280
<i>C. glaucum</i>	11.40	40.80	52.20	0.7816	11.00	39.70	50.70	0.7830	0.9713
<i>C. orchidastrum</i>	7.87	38.73	46.60	0.8311	7.66	35.41	43.07	0.8221	0.9242

Discussion

Comparative analysis of chiasma frequencies in five species of *Chlorophytum* suggests the bivalent number in these species to vary from 8 to 14 to 21 due to polyploidy present in the genus, thus confirming the earlier reports for these species (Kumar and Rao 1958, Datta and Mitra 1968, Naik 1976). Presence of univalents in species like *orchidastrum* and *glaucum* indicates the differential degree of condensation as also free terminalization ultimately leading to separation as univalents. During diplotene regular bivalents were noted, however, this differentiation takes place from prometaphase onwards. Such differences in univalent frequencies may correspond to parallel differences in random distribution of chiasmata and their free terminalization in undifferentiated homologues.

Close correspondence of mean number of chiasmata per bivalent and mean bivalent length per unit chiasma at both the stages appears to be conspicuous in *C. tuberosum* and *C. laxum*. This implies random distribution of chiasmata and continuous uninterrupted linear genic homology. Lack of such correspondence possibly due to stationary or nonshifting chiasmata indicates interrupted linear homology.

Lowest bivalent length per chiasma at metaphase I and high ranking for mean number of chiasmata per bivalent as seen in *glaucum* suggests (1) frequency being influenced more by bivalent lengths at diplotene rather than metaphase I, and (2) rate of linear condensation from diplotene to metaphase I to be relatively higher.

Interstitial chiasmata at diplotene appear to be more in *glaucum*, *tuberosum* and *orchidastrum*. It is interesting to note that at metaphase I, number of interstitial chiasmata is reduced considerably in *tuberosum* which implies random distribution, free terminalization and least linear differentiation. On the contrary, in *C. glaucum* and *orchidastrum*, though interstitial chiasmata at diplotene are more, there is relatively very little reduction at metaphase I. This clearly indicates the presence of stationary chiasmata with non-random distribution and relatively more linear differentiation.

Comparative account of chiasma frequencies at diplotene and metaphase I and terminalization reveals the possible differentiations among the species under study. In these species the basic chromosome numbers are 8 and 7. Based on the chromosome numbers reported in *Chlorophytum*, the species with $x=7$ appear to be more in number as compared to those with $x=8$. This suggests that the species with $x=7$ are relatively more adapted to climatic conditions, or the allotetraploids or polyploids of $x=7$ have developed the fixity and fluidity to withstand the climatic changes, ultimately resulting in the survival of numerous species with $x=7$. The above account on the linear differentiation as observed from the chiasma frequencies and terminalization supports this possibility. On the contrary, *laxum* and *tuberosum* with $x=8$ appear to have relatively less linear differentiation possibly due to their restricted occurrence under arid or semiarid conditions. These observations also support the earlier studies on karyotype symmetries (Patil *et al.*).

Abstract

Comparative analysis of chiasma frequencies and terminalization in five species of *Chlorophytum* suggested total number of chiasmata per PMC to be maximum in *C. glaucum* and minimum in *C. laxum* possibly due to polyploid nature of the species.

Close correspondence of mean number of chiasmata per bivalent and mean bivalent length per unit chiasma suggested least linear differentiation as observed in *C. laxum* and *C. tuberosum*. Reverse situation observed in *C. glaucum* indicated non-random distribution or stationary chiasmata with relatively more linear differentiation. This has been further confirmed from the stationary interstitial chiasmata at both diplotene/diakinesis and metaphase I stages.

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